A Comparison of Resinous Artifacts in the Ancient Near East

Honors Research Thesis

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by
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Abstract

Resinous artifacts, including amber, are one of the more common precious and useful materials found in archaeological sites in the ancient Near East. Amber was obtained by these civilizations from long-distance trade, and was seen as a precious gem. Other resins, often found locally, were used as incense, adhesives, and personal adornment among other things, oftentimes used by both the lower and the upper classes alike. Resins, however, have not been extensively studied in the Near East. By analyzing resin artifacts from eleven different sites, this study focuses on a comparison among the resins found at these chosen Near Eastern sites to understand any area- or culture-specific trends in resin quality, use, color, clarity, craftsmanship, size, and shape. Through statistical analysis of over 300 different samples, there are indeed clear-cut trends of resin characteristics and use present at certain sites. The trends provide a foundation upon which all resinous artifacts in the Near East can be analyzed. These resinous artifacts and the characteristics which link them to certain sites can give archaeologists a basis on which to further examine other similar precious artifacts. It is possible through studying these resin traits that with chemical analysis their origin and family of plant can be uncovered, leading to studies of ancient resin-gathering and trade routes. With the conclusions reached from this study, there is potential to create a basis of comparison between several Near Eastern sites and their use of precious goods, specifically resinous goods as status markers, trade items, or pieces of material culture with everyday functions.

Acknowledgements

This research has undergone many changes and has been in the works for over a year, and I would like very much to thank Dr. Joy McCorriston above all others for guiding me through and providing me with ideas when I was lost. She was a wonderful advisor and an excellent person to work with on my first major research project.

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Dedicated to the memory of my father, Jeffrey S. Creamer.

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Section 1: Introduction

The idea of cultural exchange and influence between civilizations is a concept with which anthropology has grappled. It is difficult to define and even harder to identify scientifically, and anthropologists have therefore relied on one of the only sources of evidence, material culture, to show influence from separate cultures. It is much the same in archaeology: the examination of material culture, when combined with written accounts of interaction with other cultures or civilizations, is one of the only sources of evidence for cultural exchange and influence. An excellent example of what material culture has revealed in the ancient world is the existence of extensive trade networks between separate geographical and cultural regions. The presence of trade leads to an influx of not only new and desired materials, but also acts as an economical ambassador to foreign ideas. It can be argued that the most involved form of cultural influence comes from mutual economic exchange, and with economic exchange result physical goods, some of which have lasted through the millennia to exist in the archaeological record today.

Material culture has always been an indispensable attribute to archaeological studies. As a luxury good, resins show a part of culture which hinged on personal taste and the presence of a want, but not a need. However, luxury goods are just as important to understanding past cultures as "necessary" material culture, and resins are no exception. Precious items and luxury goods are common pieces of material culture which are not unique to any time period or civilization. When so few indicators of cultural perception are available to archaeologists, these items give insights into the cultures which traded for them or created them. Because of their status as a luxury good, the design and type of resins were able to vary greatly depending on their function without losing their usefulness, and are therefore an excellent item to use to observe cultural

influence and similarities between sites. Their common use as jewelry and decoration allows for many differences in taste and fashion to be expressed between the eleven Near Eastern sites included in this study. However, resins had multiple uses besides decoration. This variety of different functions increases the need for examining resinous artifacts, as a preference towards a certain function of resins can show cultural exchange and influence as well.

Resins were chosen for this study not only for these reasons, but also due to the relatively limited area in which they can be found in the ancient Near East. As a material that is produced by trees, bushes, and other plants, most of the Near Eastern world did not have a ready supply, and trade was required to obtain this material. Resin, and especially amber, was an ideal trade item in the ancient Mediterranean and Near East and was found mainly in northern Europe – quite a distance from the Near East and its civilizations. Yet amber artifacts have been unearthed in the Near East at sites from a variety of time periods, and it is obvious that there were well-established trade routes which brought in the flow of amber to this part of the world. Because of the trade of resinous materials in the ancient Near East and the relative paucity of its natural sources in this area, this is an ideal material to analyze in order to find more information about cultural and economic interaction between the different Near Eastern and Mediterranean civilizations.

This study aimed to find measureable differences in resin artifacts between ancient Near Eastern sites by looking at physical characteristics of the samples. These differences could then be used to predict the biological origin of the resin in question, and also to observe differences in how precious materials were processed and/or what functions of resins were preferred in different areas of the Near Eastern world. Although without chemical testing it is not possible to state with complete accuracy the biological origin of the resins, through observing color, opacity,

and density, assumptions can be made in relation to a site's source of resin. Cultural differences were observed through investigating the differences between style, craftsmanship, and the type or function of the resin artifacts in the sample.

Section 2: Background

What is a Resin?

The term "resin" is a broad category under which all tree saps and plant excretions are contained. It is easy to divide this into two smaller categories: true resins (which are, as the name suggests, purely comprised of resin components) and gum-resins, which contain elements of both resin and polysaccaridic gum (Serpico 2000: 444). Fresh resin can either be in liquid or solid form; it is collected straight from the plant, either through surface gathering or through tapping the bark or, in some cases, the roots. The majority of Mediterranean resins are produced from trees of the *Pinaceae* family and *Cupressaceae* family (Serpico 2000: 445). The *Pinaceae* family includes trees such as pine, firs and cedar, while common examples of the *Cupressaceae* family are juniper and cypress – all trees which thrive in the dry Mediterranean climate. Solid resins are almost always from conifers such as those just mentioned, while liquid and gum resins tend to come from danmars, mastics, and elemis (Lambert & Poinar 2002: 629). As there are numerous records of these types of trees present in ancient resources, it can be assumed that these are also the types of trees from which resin found in the Near East was gathered in ancient times. The Near East has distinctively fewer trees and fewer varieties of trees than the broader Mediterranean area. For this reason, and because of the enormous amount of interaction between the two, it is logical to assume that most pieces of Near Eastern resins were obtained through trade. This trade was not necessarily over long distances, however, as Lebanon and other areas in the Levant had access to several species of trees and plants and, therefore, a small variety of resins already at their disposal within a relatively short distance (see Fig. 5).

There is a slight but significant difference between what constitutes amber and what constitutes a resin. However, it is easy to confuse these two ultimately similar materials when identifying the resin type of an artifact. It is important to establish a distinction between these two categories, as an archaeological find of amber could lead to many different assumptions and theories than a find of resin. Unfortunately, it is impossible to distinguish between resin and amber artifacts with the naked eye; both materials range from light yellow to dark red, are often smooth in texture, and gleam and reflect light when polished. It has been suggested, therefore, that chemical analysis can be done on pieces of several finds from each site to determine which of the two materials the site in question contains (Beck 1985: 290).

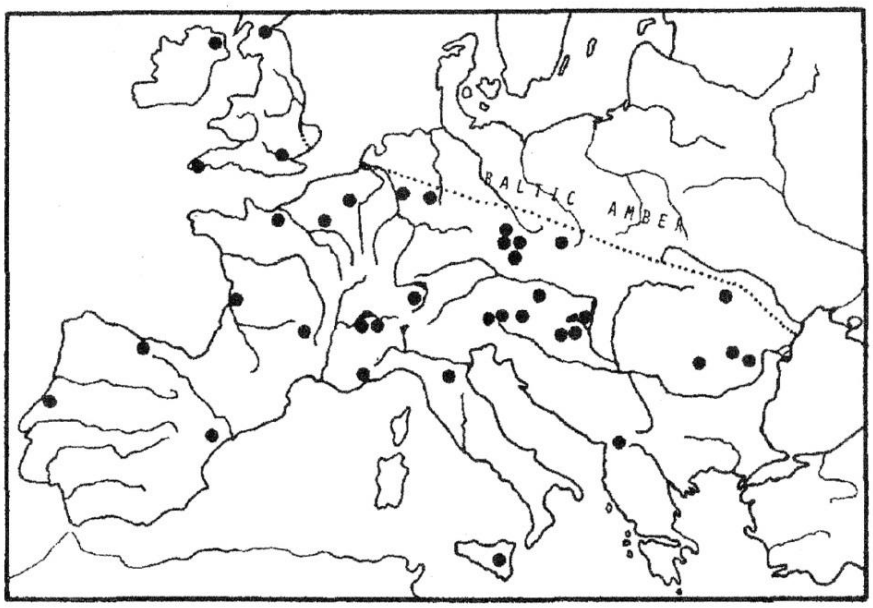
Amber, unlike some resins, was only obtained through trade routes which spanned across mainland Europe and into the Mediterranean civilizations. Because of this, amber did not appear in most parts of the Near East until the Mediterranean fostered an integrated economy and civilizations were in frequent contact. For example, it is thought that amber did not arrive in Egypt until after the XVIIIth Dynasty. (The earliest find of amber in the Near East is presently beads from a grave at Eshnunna [Tell Asmar] which were found near the Northern Palace and have been dated between 2450-2350 BC) (Harding and Hughes-Brock 1974: 146). It is important to classify amber as a separate material from all other resins, although it technically falls under that blanket term. Amber is specifically a resin that has been pressurized and hardened for over millions of years. Though some refer to amber as "fossilized resin," this term is not altogether accurate, but does serve to emphasize the difference in age between normal resin and amber.[1] It is the world's only organic material to be considered a gemstone (Singer 2008: 1). The largest known quantity of amber is found in the Baltic Sea in northern Europe; its

[1] "Fossilized" is a term for materials which have been mineralized over time, therefore losing their organic components. Amber is still an organic material.

original form was thought to be a pine resin from the genus *Pinus succinifera*, termed "succinite" by mineralogists (Beck 1970: 191). However, Jean Langenheim clarifies:

> It is clear that the amber is not derived from the modern species of Pinus, but there are mixed signals from suggestions of either an araucarian *Agathis*-like or a pinaceous *Pseudolarix*-like resin producing tree.… Although the evidence appears to lean more toward a pinaceous source, an extinct ancestral tree is probably the only solution (2003: 120).

There are more than one hundred other varieties of extremely old and hardened resins, most also called "amber" (for example, Sicilian and Romanian ambers, which originated from different tree resins). Myanmar, Mexico, the Dominican Republic, and Canada are other notable sources outside of Europe (Singer 2008: 3). These other ambers can be distinguished from Baltic amber due to the large amounts of succinic acid which Baltic amber contains; however, other varieties of European ambers also contain trace amounts of succinic acid. Fossil resins from Europe fall into two categories: Baltic ambers, and ambers similar to a group of resins termed "Agathis" (Lambert & Poinar 2002: 628). While it is difficult to distinguish these varieties, however, it still remains true that any amber without succinic acid cannot have originated from the Baltic area (Beck 1970: 193). To see where there have been natural occurrences of amber in Europe see below in Fig. 1.



Amber in Europe

Figure 1: Locations of amber sources in Europe (Beck 1970: 8)

The source of amber itself is trapped underwater; small chunks of amber will be broken off from larger underwater sources during rough tides or storms, and the buoyancy of the material allows the amber to float to the top and eventually wash up on shore, where it is found in pieces that range from as small as a pin head to larger than a basketball (such large pieces, however, are extremely rare). It is likely that amber-gathering was almost the exact same in ancient times as it is today. Tacitus writes with great interest about the "amber gatherers" – a Germanic tribe called the Aestii on the southeastern shore of the Baltic Sea (Olcott 1985: 302). His ethnography focuses more on the amber-gatherers than the gathering process itself, but Tacitus makes it clear in his remarks that the Aestii hardly valued amber due to its common occurrence, and were the main providers of the pseudo-gemstone at the time of his writing: "But they [the Aestii] alone gather the amber" (*Germania* 45.4.2). It is assumed that much of amber-gathering was done on the beaches of the sea and river mouths by wading into shallow, calmer waters (Causey 2012). Archaeological and geological studies have come to the conclusion that

there were two main sources of amber during this time: that in the area of the Jutland peninsula and the River Elbe, and the other at the estuary of the Vistula and the southeastern Baltic shore (Olcott 1985: 310). The large number of coins in the graves of the Aestii show that during this time of the early Roman Empire, amber was often traded for money rather than jewelry or other items; almost no amber remains in these sites that is worked and only small pieces of raw amber have been found. It was from this area that nearly all of the amber found in the Classical and Near Eastern world originated. Though the main area of gathering Baltic amber is in areas of northern Europe, it can also be found naturally as far south as southern Russia, although those deposits are not considered to have played as important of a part in amber trade (Harding and Hughes-Brock 1974: 156). Other, much smaller sources of amber with different chemical compounds have also been found in Sicily, Romania, and even Israel, Lebanon, and Jordan – all of which are much closer, and could potentially be the sources of non-Baltic amber found in the ancient Near East (Causey 2012).

The Culture of Resins in Antiquity

Amber, and undoubtedly the other resins which closely resembled it, was a status item and displayed both prestige and wealth by those who owned it. "Access to, and the display and deposition of, 'highly-valued' objects and materials is often associated with the activities of elites," (Green 2006: 69). However, it was even more than an exhibition of prestige and wealth to their ancient owners; amber, in many cultures, was thought to promote healing and protection. This attribute made it popular as an amulet, and it is thought that amber was placed in the graves

of children in order to give them protection (Bonfante 2007: 286).[2] A similar phenomenon appeared in Egypt, where small pieces of amber were found inserted beneath the skin and wraps in mummies, also to afford protection to the dead (Todd 1985: 292). Amulets and the magic associated with them were a very important aspect of ancient life, especially in the Near East. In fact, most stones or objects could be considered to have some form of supernatural property but, as T. G. H. James suggests, "[a]lthough certain materials, semiprecious stones in particular, were invested with magical properties in ancient Egypt, it seems that these properties were usually only activated when the stone in question was used for the manufacture of amuletic figures of specific kinds" (1997: 304).

The Mesopotamians also felt strongly about amulets and their magical properties, perhaps best evidenced by an entire set of instructions for a "rubbing ritual," translated by Barbara Böck. The text gives orders for a ritual that is healing in nature with the amulets being pressed over different parts of the body.[3] Amber, with its warm touch and pleasant color, might have been favored as an amulet in rituals such as this. Faya Causey comments, "[a]mber might have been especially effective in magically attracting the sun, due to its inherent magnetic property and because of amber's 'sympathetic' brilliance and color: like would attract like" (2012). It was not only amber which possessed this "sunny" color and magnetic attraction. It is likely that, just as today, it was hard to tell the difference between many resins and amber. Whether a deliberate deceptive action on the seller's part, or if the buyer actively wanted to purchase resin instead of amber, miscellaneous resins are found quite often with or instead of genuine Baltic amber. One of the most notable cases is from Tutankhamen's tomb, in which various non-amber resins were

[2] Amber and resins identified as "grave goods" are common, but the hierarchical, socio-economic, and other cultural implications of resin and amber in burials is beyond the scope of this study. For more information about the common practices and theories regarding grave good analysis, consult Green 2006.
[3] For the entire translation of the ritual, see Böck, 2003. It should also be noted that incense is used in the ritual as well, adding to the potential uses of resin in magical rituals and medicine.

found displayed as if they were amber (Causey 2012). Another was found in excavations at Eshnunna (Tell Asmar) which revealed a small pendant dated to the Proto-Imperial period (c. 2500-2400 BC). After chemical testing, this pendant turned out to be a resin named copal instead of amber (Beck 1991: 270).

Resins, and amber specifically, are mentioned in many ancient Near Eastern sources, and the value placed on this pseudo-gemstone is remarkable, even if unsurprising. The Bible, rabbinic commentaries, the *Epic of Gilgamesh*, and the Nippur Temple texts are just a few examples which mention amber and its associated value and characteristics. Also related to amber is the Akkadian word "*elmešu*", listed as "a precious stone of characteristic sparkle and brilliancy" (*Chicago Assyrian Dictionary E108*). It hardly ever was written with the determinative indicative of stone, however, but is instead listed among mineral dyes. The *elmešu* stone is thought to have been also used as an adjective for a color, and Todd suggests that this color was the brilliant yellow-gold of amber (similar to our use of the word "amber" as both a material and a color) (Todd 1985: 298). *Elmešu* appears most famously in *Gilgamesh*, where it describes what the horns of a chariot will be made of (*Gilgamesh* VI. 11). Studies have shown that amber was also used as one of the gemstones to adorn breastplates and other ornaments for kings and priests, and it is suggested that it was one of the materials used to decorate the breastplate of the High Priest in Exodus 28:15-21 (Todd 1985: 299). In the *Odyssey*, the word "amber" is mentioned several times by Homer, especially as a Phoenician trade item (Berry 1927: 270). It was worn by kings, heroes, and priests; it decorated sacred and powerful items (Todd 1985: 299). These references to amber, in addition to its presence among expensive and desirable grave goods, show that this material was associated with not only supernatural

characteristics such as healing and protection, but also with much more worldly attributes such as money and power.

As mentioned earlier, one of resin's greatest qualities is its colors – all warm golden and reddish hues which easily recall visions of the sun and light. This characteristic of imitating light and warmth is arguably the greatest attraction which resins (and specifically amber) held for ancient cultures. The quality of "light-bearing" or "shining" was always a positive one in ancient imagery and mythology, as can be evidenced by the multitude of sun gods in ancient pantheons. In Greece, Egypt, and many areas of the Near East, gods and some heroic figures are described with the above adjectives in addition to "golden," "bright," and "luminous" (Causey 2012). I. Winter has written several works about the qualities of light in Mesopotamia and emphasizes, "the quality of intense light, or radiance, emanating from a particular work is one of the most positive attributes in descriptions of what we would call Mesopotamian 'art'," (1994: 123). In addition to this, she writes, "[i]n all cases, it is apparently the combination of light-plus-sheen yielding a kind of lustrousness that is seen as particularly positive and auspicious, so that person and things that are holy, ritually pure, joyous or beautiful are generally described in terms of light" (1994: 123). Similar to this, the term "*tjehnet*" in Egyptian has a meaning equivalent to "dazzling" or "brilliant" and is applied to many gods as well as faience, precious metals, and shining objects (such as, for example, amber). This shining characteristic was valued as a quality which promoted healing and rebirth (Friedman 1998: 15, 28-29). It is no wonder then that amber and other resins became such popular materials in these areas of the ancient Near East.

Resin and its numerous forms have many uses (even into the modern day). Solid resins, as mentioned earlier, were shaped and carved into pieces of jewelry such as pendants, beads, and

even amulets.[4] Resin's variety of viscosities often allowed it to be shaped more easily than amber, although its softened state also meant that it could be damaged more easily than amber pieces. Ultimately, however, while amber proved to be the best decoration, resins were employed in numerous useful ways; for example, they were used as adhesives, ingredients in sweet-smelling body oils or perfumes, incense both for domestic and ritual purposes, mortar, and even as varnishes on wooden furniture (Serpico 2000: 430). In Egypt, both resins and bitumen were applied to the deceased during parts of the mummification process in the New Kingdom. The perfumed body oils made out of resin were applied on the dead as well as the living in other parts of the Near East, and the incense was burned at funerals and temple services (Serpico 2000: 432). Resin and amber's connection between both the worlds of the living and the dead is undeniable.

Amber was a somewhat of a rarity in the ancient Near East and was often only obtained through trade in small pieces. Large chunks of amber were rare and undoubtedly valuable (the largest piece examined in this study was only 66mm long, and there were only 20 pieces examined that were over 40mm in length out of 336). Because of this size limitation and the visually-pleasing properties of amber, its most common use was in jewelry and other various forms of personal adornment. Almost all samples of resin and amber analyzed in this study were beads, showing how prevalent this material was in jewelry and decoration.[5]

Resins worked particularly well as incense because, even though they are organic matter, they burned very slowly when tossed among or over coals and, when mixed with other

[4] Pliny notes that in Syria, women even used amber as spindle whorls in weaving, due to its tendency to pick up the fringes of the garments they were weaving with static electricity (*Natural History, Book 37*).
[5] This large number of beads should not be taken to mean that at these sites decoration was the only use for amber and resins; archaeological evidence is limited to what was found. This means that, while beads are usually included in graves and are complete enough to notice in an excavation, other pieces of resin, like those used as adhesives or incense, could be easily overlooked and therefore not part of the archaeological record today.

fragrances like bark or flowers, the scent of these would linger mixed with the resin (Serpico 2000: 457). Most well-known today for their scents are the resins frankincense and myrrh, but most resins exuded a pleasant scent, especially when rubbed or heated. Specifically in the ancient Near East, *Pistacia* resin is thought to have been a common fragrance; in a Late Bronze Age shipwreck at Ulu Burun off the coast of Turkey, large quantities of *Pistacia* resin were found in amphorae. In Tell el Amarna, in Egypt, imported Canaanite amphorae were excavated which also contained *Pistacia* resin (theories have been formed which specifically link the Egyptian word "*sntr*," translated as "incense," to *Pistacia* resin) (Serpico 2000: 458).

Furniture, especially in Egypt, has been found with darkened, opaque varnishes. This varnish used to be much lighter but has darkened over time, and has been identified as a resin. Resin has been found coating various objects, most notably coffins, shabti boxes in Egypt, figurines, vases, and even tomb walls (Serpico 2000: 459). Some archaeologists have proposed that this is not due to the inherent preservation qualities of resin, but rather its connection to the afterlife (Sherratt 1995). Scented oils and ointments were produced in numerous areas of the Near East and mainly in Egypt and Mesopotamia (Serpico 2000: 461). Often these ointments were mixed with a lipid base and the scents were made by adding the resins among other ingredients.[6]

Amulets, beads, and adornment, however, remain the most popular use of many resins and ambers. This use is not despite their strong scent, but rather, it has been argued that resin was a popular material because of it (Causey 2012). Amber and resin amulets and beads were popular to wear not only because of their attractive gleam and coloring (see Fig. 10), but also for tactile sensations; rubbing or touching amber and resins made them warm (warmer than the stones and gems used for the same purpose, due to their organic components) and by rubbing the

[6] The methods of producing these unguents are thoroughly explained in Serpico 2000 on pages 460-464.

resin jewelry, a faint, pleasant scent could be released. As Faya Causey comments, "its magnetic properties, distinctive, glowing, sunlike color and liquid appearance, inclusions and luster, and exotic origins were mysterious and awe-inspiring," (2012). Amber in Greco-Roman times as well was considered to have divine properties, mostly related to health, protection, and electricity. Though Pliny the Elder seemed hesitant to appreciate amber as much as those around him, ("not even luxury has yet succeeded in inventing a justification for using amber") he talks freely about its supposed origins and its uses, specifically in medicine and healing (*Natural History, Book 37*).[7] This association between amber and the divine can be easily seen in the ancient Near East in writing (as discussed above), burials, and decoration.

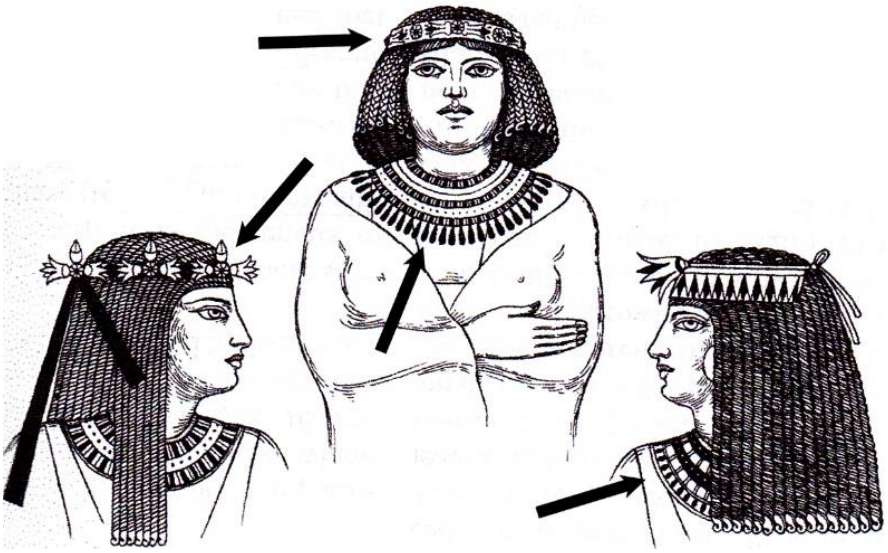


Figure 2: Examples of Egyptian jewelry (Galway 1954: 11)

Examples of jewelry types in which ambers and resins were featured include bands, jeweled bandeaus for hair, earrings, bracelets, and amulets (Stout: 2001). (See Figs. 2 and 3

[7] Pliny the Elder discusses amber somewhat in depth. One origin story he mentions is that it was thought to be "crystallized lynx urine." He mentions also the story of amber originating from the tears of nymphs as they cried over a god's death in Greek mythology, before adding his own (correct) belief that it was hardened tree sap (*Natural History, Book 37*). These several common myths about amber's origin, however, show just how popular an item it was in the ancient world.

above and below for examples.) Mary Galway also maintains that almost all Assyrian motifs are geometric; the same tendency towards geometric designs is seen in most of the resin beads from Nippur included in this study in Section 4 (Galway 1954: 158). Beads have been included in burials for thousands of years, and are arguably the most common grave good along with organic materials and pottery (Swain 1992: 35).

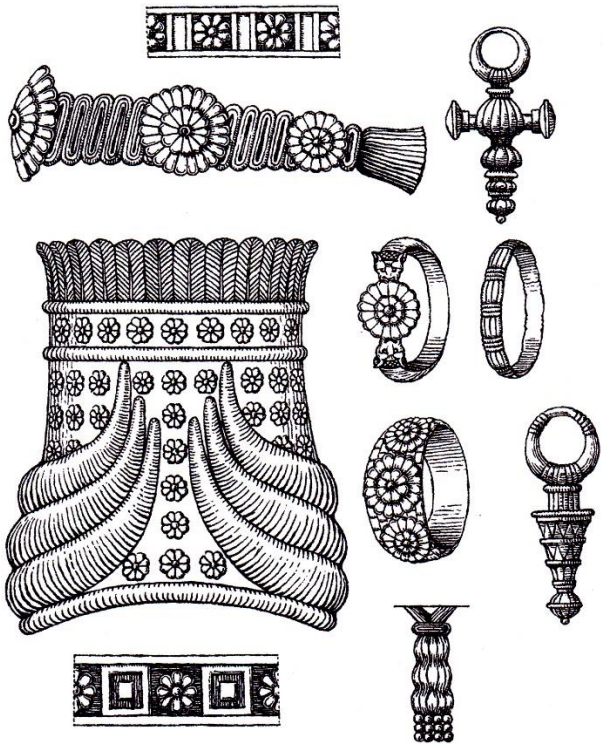


Figure 3: Examples of Assyrian jewelry and decoration (Galway 1954: 157)

Another quality of resins and amber which undoubtedly made them attractive to craftsmen was their softness. Amber is only a 2 or 3 on the Mohs hardness scale (diamond being a 10), and most resins are even lower (Causey 2012).[8] Its relative softness makes it easily worked, and it could therefore be fashioned into jewelry or other objects by artisans of all levels (the craftsmanship of resins and ambers is analyzed in this study in Section 4). Also because of

[8] Differences in hardness occur in varieties of amber; for example, Lebanese amber is known to be significantly softer and more fragile than Baltic amber, making it harder to carve without fractures. However, Lebanese amber can be melted, unlike Baltic amber, and can be pressed to produce ambroid, a material similar, but inferior to amber and less popular (Poinar and Milki 2001).

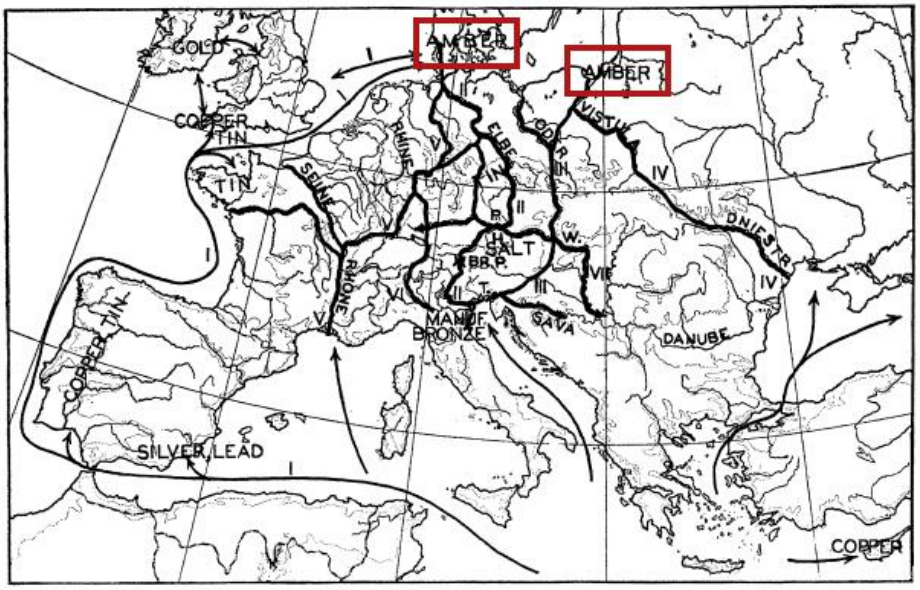
this softness, ambers and resins were remarkably similar in that effect to ivory, and it has been suggested that ivory-carvers were employed in carving ambers as well. Waarsenburg writes specifically about the "intimate links between ivory- and amber-carving as well as their close connection with jeweler's workshops," and goes on to argue that archaeologists should look for carving workshops in general, rather than amber workshops individually (1995: 428). Ivory workshops discovered at Hasanlu, one of the sites analyzed in this study, were shown to have also been in the business of carving wood and bone (Muscarella 1980). This style of multi-material workshops fits into a general pattern found in the Near East; it is not surprising that resin- and amber-working would be part of it.

The Trade of Resins and Amber

The question of trade routes is one which goes hand-in-hand with this study. Most of the Near East is comprised of an arid climate and loose, dry soil; it goes without saying that the trees and bushes needed to produce resin did not grow next to most of these civilizations. Like many other valuable items in the ancient world (and especially in the Mediterranean and Near East), resins and amber were shipped through trade.

It is not a question of "if" resin and amber trade existed in the Near East, but rather "how" and "why." The "why" was mentioned earlier: amber and resins were status items, they possessed attractive tactile, visual, and aromatic qualities, and were considered to have magical properties related to health and protection in almost all cultures. Now it is time to examine the "how": how were these resins traded throughout the Near East, some (like the copal pendant from Eshnunna and all specimens of Baltic amber) from thousands of miles away?

First, however, it is important to understand the definition of "trade"; according to Renfrew, trade is "the reciprocal traffic, exchange, or movement of materials or goods through peaceful human agency (1969: 152).[9] With this as the working definition, and assuming that the transport of amber and resins was carried out in this manner, then one can begin to examine the suggested trade routes which brought in these materials.



PREHISTORIC TRADE ROUTES IN EUROPE

Figure 4: Prehistoric Trade Routes in Europe (Cleland 1927: 235)

The trade of resins is widely varied and depends largely on the specific resins in demand and their natural geographical origin (see Fig. 5 for tree and bush families and their biological climate zones). For this reason, not much has been done to trace resin trade routes beyond the discussion of the locations where resins have been found outside of the areas in which they could naturally occur. However, Baltic amber, because of its easily-identifiable infrared spectrum (due to the large amounts of succinite present in it) has been studied extensively and many potential

[9] Renfrew goes on to describe trade's functions as a source of wealth, a push towards specialized production, a source of cultural and social contact, and a catalyst by which new demand is created for objects otherwise unavailable (1969: 153).

trade routes have been presented for consideration. As the Baltic amber trade routes were closely tied with the tin trade in the Bronze Age, these roads were well-known and there is little question of their veracity (see Fig. 4) (Cleland 1927: 238). Because of amber's connection with tin (which was used to make bronze), it was not unusual for the two objects to travel together in the same caravan. As Cleland mentions, amber was an ideal trade item because it was so light and small that it could be tucked into pouches or clothes, but it was still valuable (1927: 238). He even suggests that the rise of bronze and tin trade routes was a direct result of amber's popularity, rather than trade in amber originating from tin and bronze trade missions (1927: 234).

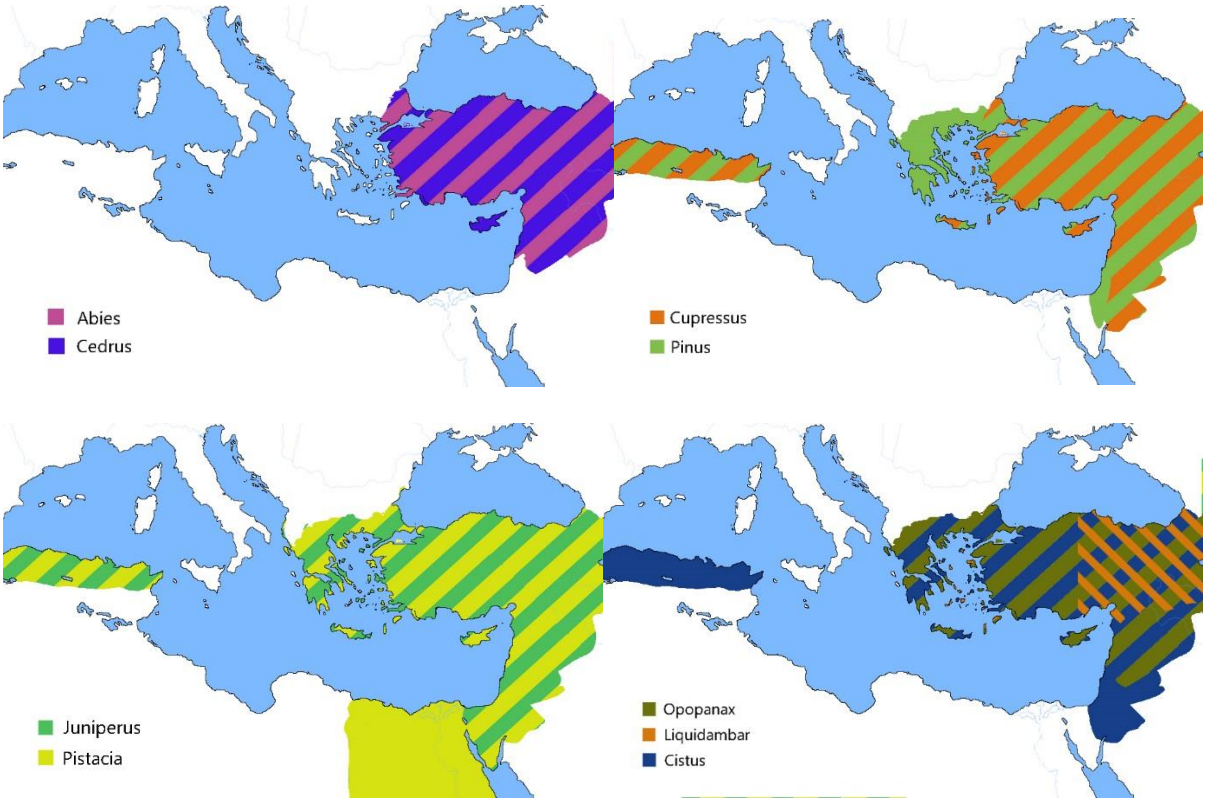


Figure 5: Maps of different plant families and their locations in the Mediterranean and Near East

As an archaeological indicator of trade, Baltic amber is excellent.[10] There are no known succinic amber deposits in the Near East, itself – any amber beads, amulets, or other decorations which contain succinite are known to have originated outside of their penultimate resting place in Near Eastern sites. According to Causey, however, "of the varieties used in antiquity and known today, only succinite, or Baltic amber, is found in the large, relatively sturdy jewelry-grade pieces such as were used for the sizable objects of antiquity" (2012).[11] In the early stages of amber trade, Baltic amber was most likely transported to the Mediterranean region through a series of exchanges, rather than a long trading trip. There was no defined long-distance amber trade until bronze and tin became popular in the 2nd millennium BC, and it was most likely that amber was still traded mainly to the Mediterranean countries of Europe, only arriving in the Near East on their ships. As stated by Causey, "[t]rade in amber was likely a series of short-range transactions from the sources onward" (2012).

The earliest evidence for long-distance resin trade to the Near East has been debated, but some dates include c. 2500 BC from the pendant found at Eshnunna, or c. 1800 BC, from two beads found at Assur; amber beads were even found in the tomb of Teti at Saqqara in Egypt, c. 2340 BC (Singer 2008:3). The pendant from Eshnunna, after chemical testing by C.W. Beck, was found to be a type of copal, rather than amber – one from East Africa or Madagascar. Not only is this the earliest case of a foreign resin in the Near East, it is also the earliest evidence so far for contact between Mesopotamia and this region of Africa (Meyer et al. 1991: 290) (Beck 1991: 297). In Egypt, amber is attested with a high degree of probability from the 18th Dynasty

[10] Navarro was one of the first scholars to discuss amber trade in Europe quite extensively. For a breakdown of European amber finds, see Navarro 1925.

[11] To learn more about Near Eastern amber specifically, see Poinar and Milki 2001. Although they describe fairly large pieces of amber in their work, it is important to note that Lebanese amber is hardly ever collected in pieces larger than a centimeter in diameter and is hard to work, which probably contributed to the popularity of Baltic amber instead (Causey 2012).

(1550-1295 BC) onwards, but was still rare and only found with other exceptional materials such as crystals, lapis lazuli, and gold (Causey 2012). Baltic amber specifically was found in sites whose dates ranged through the Late Bronze (Aphek in Israel and Wadi Tarafa in Jordan), Iron I and II (Tell Fa'rah and Lahav), Roman and Byzantine (Jerusalem, Shikmona, and Nazareth), and Arab periods (Todd 1985: 292). These sites mentioned are only a few out of more than fifty Near Eastern sites which contained amber during a search in 1983 (Todd 1985: 297). Undoubtedly the flow of amber into the Near East became much more common during the eras of contact and cultural exchange with both Greece and Rome, but the presence of amber in the ancient Near East before that shows an even earlier extensive trade route system, most likely related to the previously-mentioned trade of tin and bronze in the Bronze Age. Joan M. Todd states that "amber use in the ancient Near East has had remarkable continuity" (1985: 300).

The "Amber Road" is a term that has been coined to describe the travels of amber from its source in the Baltic and connected rivers to various areas in the Mediterranean and Near East (Beck 1970). However, was it really a road, or was the amber trade carried out more commonly by waterways? B. Lundman revisits the argument of land vs. sea trade routes, specifically in connection with amber. Lundman argues that Near Eastern sea-farers, such as the Phoenicians, travelled up to the North Sea to barter for amber in person, close to the source and bringing bronze (1957: 114). While Oriental trade missions travelling all the way to the North Sea can be debated, the fact that resin trade was common on the Mediterranean Sea was undeniable. Beads of Baltic amber were present at an earlier-mentioned shipwreck which happened in the late 14th century BC at Ulu Burun, on the southern coast of Turkey (Pulak 2000: 218). The residue of *Pistacia* resin was found in sea vessels travelling from Canaan (Dollinger 2000). In addition, Navarro writes, "[a]ll I can say is that the evidence is not at present sufficient to warrant the

assumption that there was a transcontinental trade in amber, prior to the Bronze Age. If Northern amber was finding its way to the Mediterranean before that epoch it must have come by sea," (1925: 483). During the Bronze Age, however, there was early academic agreement that the trade in Baltic amber flourished, and that trade routes on land were just as common as those on the sea ("Ancient Trade Routes Traced" 1926: 7). This stance has not changed; it is still agreed that amber was traded with high intensity, reaching its zenith around the 7th century BC, gradually declining until the 4th century BC (Navarro 1925: 480).

Mediterranean distribution of the principal resin-producing coniferous trees and shrubs.

	S. Med. Coast			E. Med. Coast				N. Med. Coast and Aegean					
	Eg	Si	NA	Is	Jo	Le	Sy	ET	WT	Cy	Cr	AI	Gr
Pinus halepensis			X	X	X	X	X	X		O			O
Pinus pinea				O		X		?	?	O	O	X	X
Pinus brutia						X	X	X	X	X	X	X	X
Pinus nigra							?	X	X	X	O	X	X
Cedrus libani						X	X	X	X	X			
Abies cilicica						X	X	X	X				
Juniperus oxycedrus				X		X	X	X	X	X	X	X	X
Juniperus communis								X	X				X
Juniperus drupacea						X	X	X	X				X
Juniperus phoenicia		X	X		X				X	X	X	X	X
Juniperus foetidissima						X		X	X	X		X	X
Juniperus excelsa						X	X	X	X	X		X	X
Cupressus sempervirens			X		X	X	X	X	X	X	X	X	

Mediterranean distribution of some non-coniferous resin-producing plants.

	S. Med. Coast			E. Med. Coast				N. Med. Coast and Aegean					
	Eg	Si	NA	Is	Jo	Le	Sy	ET	WT	Cy	Cr	AI	Gr
Pistacia atlantica		X	X	X	X	X	X	X	X	O		O	X
Pistacia terebinthus				X	X	X	X	X	X	X	X	X	X
Pistacia khiniuk	X	X			X		X	X					
Pistacia lentiscus			X	X	X	X	X	X	X	X	X	X	X
Pistacia eurycarpa							X	X					
Cistus creticus				X	X	X	X	X	X	X	X	X	X
Cistus laurifolius			X					X	X				X
Liquidambar orientalis									X			X	
Opopanax chironium									X				X
Opopanax hispidium							X	X		X	X	X	X
Opopanax syriacum						X	X						

Abbreviations: Eg = Egypt, Si = Sinai, NA = North Africa, Is = Israel, Jo = Jordan, Le = Lebanon, Sy = Syria, ET = south Eastern Turkey (east of 32°), WT = south Western Turkey (west of 32°), Cy = Cyprus, Cr = Crete, AI = Aegean Islands, Gr = Greece.

Concordance: X = present, O = distribution in dispute, ? = possibly indigenous.

Figure 6: Charts by Margaret Serpico of the distribution of resin-bearing plants throughout the Mediterranean and Near East (Serpico 2000). For clarification on the common names of the species of trees, see Appendix.

The Sites Analyzed in this Study

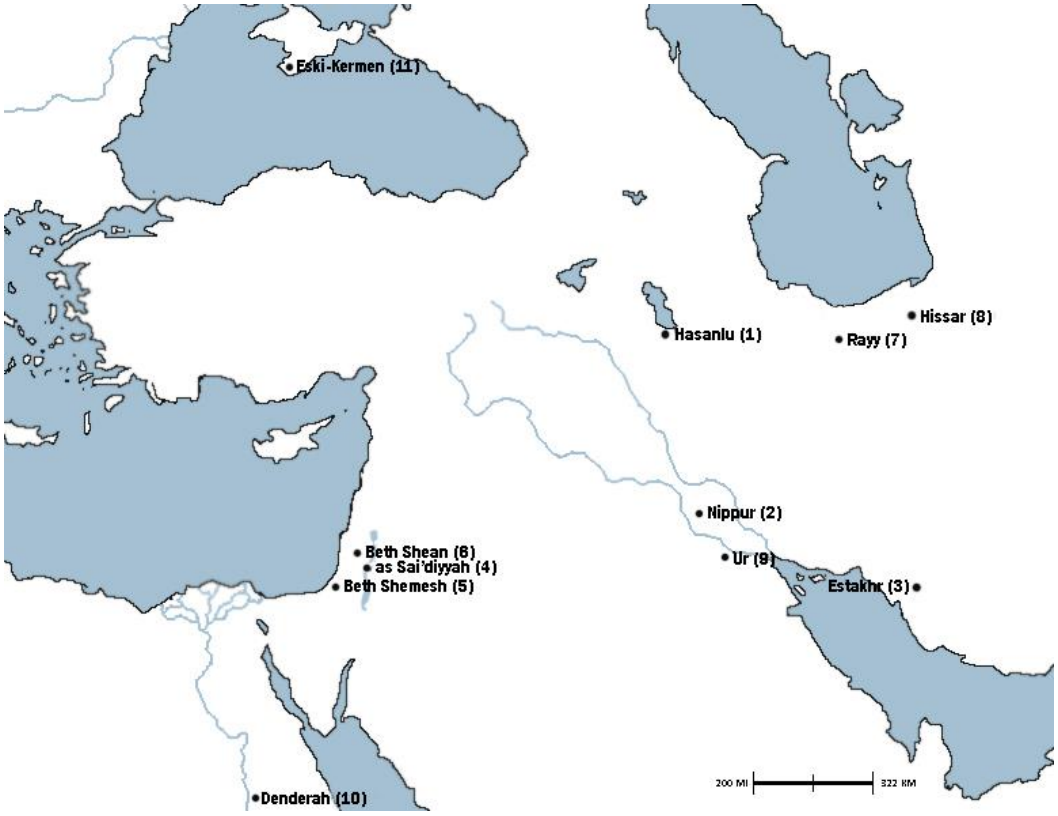


Figure 7: A map of the eleven sites of this study in the Near East

· Site 1: Hasanlu

The majority of this study's objects (205 artifacts) come from the University of Pennsylvania's excavations at Hasanlu. Hasanlu is a site in current-day Iran which was occupied from the latter half of the second millennium BC until around 800 BC (Dyson 1989: 3). It is considered an early Iron Age site and all resins which were recovered from the Penn excavations at Hasanlu are from that time period. All resins from Hasanlu were found in a single burned building which was part of an event in the site's history termed "The Great Fire" (Hasanlu period IVB; Iron Age II level c. 800 BC) (Dyson 1989: 5). Hasanlu was strategically located on trade routes which led from Urartu, Assyria, Syria, Mannea, and Media and Dyson points out that "[t]here is little reason to doubt the presence of foreigners at the site, either as occasional visitors

or residents" (1989: 8). Therefore, it should be noted in this study that established trade routes ran through Hasanlu, by means of which it can be assumed much of the resins excavated at this site were obtained. Foreign influence could have affected the style, type, and craftsmanship of the resins from Hasanlu.

· Site 2: Nippur

Nippur is a Sumerian site located in the very center of the southern Mesopotamian floodplain. The city's occupation spans for over 6,000 years – from the Ubaid period (c. 5500 BC) to roughly 800 AD in the Islamic period. It was one of Mesopotamia's largest and most important cities and was a hub of trade and travel; it is not hard to imagine how these pieces of resin ended up buried here (Penn Museum: 2013). Nippur was first excavated by the University of Pennsylvania in 1888, during which most of the resin artifacts were acquired (Peters 1899: 119). Unfortunately, due to the size of this site and the lengthy time during which it was occupied, it is hard to place the resin artifacts (which lack field numbers or any form of provenience) in any specific time period. There are only three resin beads which have loci attached to them, and they are all from Burial 29. Due to Nippur's geographical proximity and cultural similarities with Ur, one expects the resin artifacts from both sites will be similar.

· Site 3: Estakhr

Estakhr is an Achaemenid site in Iran. It is situated at the northeast corner of the Arabian Peninsula in a convenient location to become a main stop along the caravan trade route of the Silk Road (Bivar and Boyce 1998). It was temporarily the capital of Sassanian Persia from 224-242 AD under Ardashir I. The collections of resins from Estakhr resulted from a 1930

excavation led by the Oriental Institute in a partnership with the University of Pennsylvania, in which both kept poor field notes and released hardly any records of the excavation. They lack field numbers and no indication of their locus was attached to their files. The levels excavated during this time were pre-Islamic in nature, so it can be assumed that these beads are also from a pre-Islamic time period, despite having almost no information about them (Wilkinson 1971: 62). However, Estakhr's presence along the Silk Road undoubtedly fostered trade in other items as well, resins being potentially one of them.

· Site 4: as Sai'diyyah

Tell as Sai'diyyah was excavated by the Penn Museum to examine its Bronze-to-Iron Age occupation levels. Tell as Sai'diyyah is a remarkable example in Jordanian archaeology of large quantities of imports from Egypt, especially in the Late Bronze Age (McGovern 2004: 295). Burial customs and grave goods were also heavily influenced by Egyptian culture, and it should be expected, therefore, that this study will find a similarity between Tell as Sai'diyyah's resin artifacts and those from Denderah (Site 10). The resin artifacts in question were found in levels corresponding to Iron Age I and are estimated to have been in use between 1300-1000 BC (Penn Museum 2013). Geographically, similarities should also be expected between the three sites of as Sai'diyyah, Beth Shemesh, and Beth Shean in light of their mutual proximities (Fig. 7).

· Site 5: Beth Shemesh

Beth Shemesh is a Canaanite site just west of the Jordan River. It was occupied from c. 2000 BC to around 600 BC, and is considered a Biblical site. The resin objects found here

consist of five pieces of badly-deteriorated beads: two pieces were found in a treasure jar, the others were found between loci III and IV (dated to around 1500 BC) (Penn Museum 2013). All objects from Beth Shemesh were purchased by the Penn Museum from Haverford College, which carried out excavations there from 1928-1933 ("Expedition News" 1961: 11). As mentioned above, one might expect to find similarities between these resin artifacts and those of Tell as Sai'diyyah and Beth Shean.

· Site 6: Beth Shean

Tell Beth Shean was first investigated on a large scale by the University of Pennsylvania expedition from 1921 to 1933, during which important discoveries were made, mainly regarding the three hundred years of Egyptian rule in Canaan (ca. 1450 to 1150 BC). Beth Shean was occupied from the 6th millennium BC through the 8th century BC, in which it was taken by Assyrian invasion: after the 8th century, occupation was minimal until the 2nd century BC, when it reemerged into the Hellenistic period and prospered into Late Antiquity (Ousterhout 2013: 9). It was excavated by the University of Pennsylvania in 1921, and dated as following the collapse of the Ottoman Empire: Clarence Fisher, the head archaeologist, primarily focused on the Bronze Age levels, which is where the resin finds from this site originate (Penn Museum 2013). Similarities were expected to be found between Beth Shean, Beth Shemesh, and as Sai'diyyah.

· Site 7: Rayy

Rayy is a site which was excavated by Erich Schmidt under University of Pennsylvania, this time in the seasons of 1933-1936. Occupation began in 6,000 BC; the resins analyzed from Rayy are estimated to be from 5,000-3,000 BC but no locus was attached to the artifacts' data

(Rante 2010) (Penn Museum 2013). Rayy, like several other sites included in this study, was located at an intersection of trade routes running from the Near East towards Bactria and India. As will be discussed in Section 4, many of these items found at Rayy were linked strongly in style with Tepe Hissar, which makes sense because of their geographical proximity (see Fig. 7).

· Site 8: Hissar

Erich Schmidt, the excavator of Rayy, also excavated Tepe Hissar in 1931-1933, a site occupied from the Bronze through the Islamic Age. Schmidt focused on Bronze – Sassanian periods while he excavated, and over sixteen hundred graves were recorded: of these, 782 objects from 1932 formed the basis of the 1937 tabular presentation of burial data. Four rich graves of section IIIC in Hissar were found in 1931 (IIIC was dated between 2170-1900 BC) (Dyson 2009). Only one bead was present in this study from Tepe Hissar (Field no. CF 36).

· Site 9: Ur

Ur was a Sumerian city in southern Mesopotamia at the mouth of the Euphrates, excavated by Sir Leonard Wooley between 1922 and 1934. Its location made it a bustling port-city on the Persian Gulf beginning most likely during its first occupation in the Ubaid period (5000-4100 BC) (Mark 2011). Two resin pieces were found here which are included in this study – unfortunately, no provenience is attached to them. It is estimated that they originated between the 3rd millennium and the 2nd millennium BC (Penn Museum 2013).

· Site 10: Denderah

Denderah is located roughly 375 miles south of Cairo on the eastern edge of the Nile Valley. It is most famous to tourists for its temple, but for archaeologists the graveyard behind the temple holds more interest. It was a town which flourished between 2200 BC and 1700 BC during which thousands of burials were made. Wealthy burials were made with mastabas, while poorer ones consist of shallow shafts, sometimes with four individuals or more (Slater 1970: 15). The resins taken from excavations at Denderah unfortunately do not have loci attached to the field numbers, but it can be safely assumed that these artifacts (mostly beads) were acquired from some of the richer graves.

· Site 11: Eski-Kermen

The final site is located in the Crimean peninsula in southern Ukraine, on the outer edges of what archaeologists term the "Near East." All resins from Crimea were recovered from graves or catacombs at Eski-Kermen in the southern tip of Crimea. This site is made up of a rocky man-made cave system (over 300 caves) occupied from 500 AD onwards. First commissioned by the Byzantines as a stronghold, it was later used as a Gothic fortress of sorts; its high position on a plateau and its rocky exterior served as an excellent defense (Permanent Delegation UNESCO 2012). The resins recovered from the graves in Eski-Kermen were excavated by Eugene A. Golomstock's expedition under Penn, and were found in layers corresponding to a date between 500-600 AD for all of them.

Section 3: Methodology

In this study, the examined samples of amber and resinous artifacts belonged to the collections at the University of Pennsylvania Museum of Archaeology and Anthropology. All amber and resin artifacts examined were from the ancient Near East, from the eleven separate sites mentioned above: Hasanlu, Nippur, Estakhr, as Sai'diyyah, Beth Shemesh, Beth Shean, Rayy, Hissar, Ur, Denderah, and Eski-Kermen. From these sites, 336 objects were analyzed. This large number of artifacts, however, is comprised of samples gathered from a variety of excavation techniques, observations, and records – all of which are obstacles for any study conducted based on archaeological artifacts and contexts. For example, in this study, contextual records and even field numbers were absent for objects from Rayy, Hissar, Ur, Estakhr, Denderah, and for some of the pieces from Beth Shemesh, Nippur, and Hasanlu. This lack of information makes statistical evaluations difficult, but this study attempted systematically to extract usable and relevant information pertaining to the many uses and forms of resin present across the ancient Near East. There is a numerical bias with items from the Hasanlu, Nippur, Denderah, and Eski-Kermen excavations carried out by the Penn Museum; the number of resin beads and figurines from these sites made up more than half of the entire studied pieces. Therefore, this study provides the most comparative data about these sites. The other sites which objects were taken from, however, are by no means unobservable; this large difference in sample sizes is taken into account in the statistical observations made and in the conclusions drawn from this study.

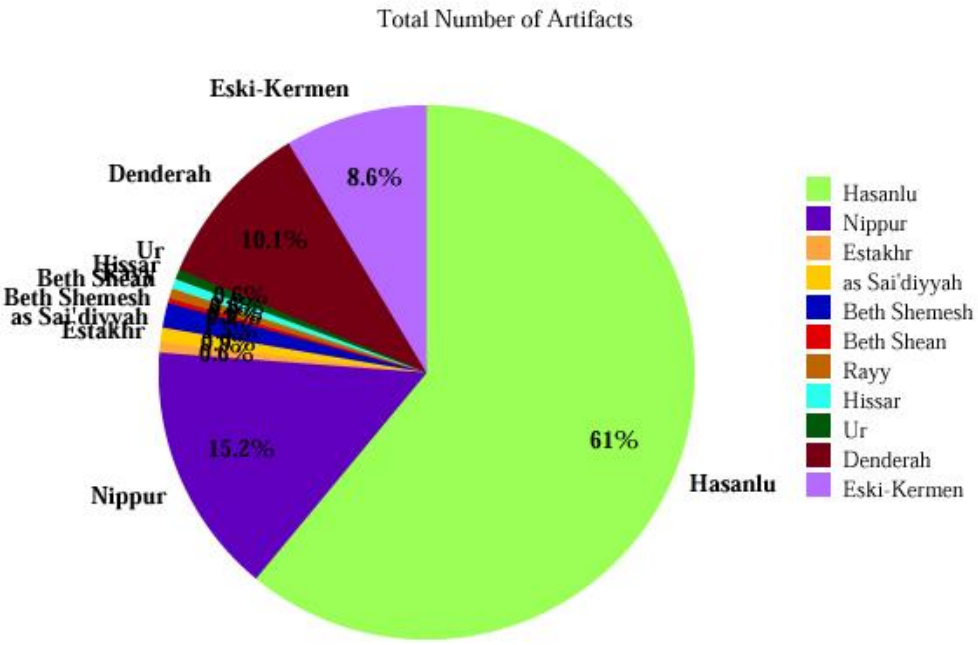


Figure 8: A pie chart of the total number of resinous artifacts in this study

Each artifact was scrutinized in the light of a wide variety of qualities. In order to take into account the quality of the piece (and therefore presumably a higher value when it was crafted and exchanged) this study examined the size of the piece, its weight, its color, the shape, the craftsmanship of the item, its clarity, whether there were any inclusions or bubble present in the resin, and the function the artifact was crafted to fulfill.

Quantitative Analysis

· Size: The size of the artifact is an obvious quality to start with, and can provide information about not only the wealth of a certain site or person, but also how large the original, unworked resin pieces could have been. The height, width, and length were measured for each artifact. In this study, the estimated volume is used as the size value; while not an entirely accurate measure of volume due to the odd shapes of some artifacts and the holes cut in others,

this value is indicative of the size of the pieces of resin to which crafters had access, or perhaps the sizes of beads which were popular at the site. An overall idea of the size of the resin artifacts found at a certain site may be significant in drawing possible conclusions about the type of resin used and in what way the resin was obtained. Hypothetically, a consistent amount of very small beads, for example, could indicate trade or a repurposing of resin materials, while consistently larger resin artifacts could indicate a direct access to the resin source.

· Weight: Each object was weighed on a small scale (artifacts which were in two or more pieces were weighed together). The weight of each object was considered in relation to the estimated volume in order to estimate the density of each artifact. The differences in density, however, were so slight between different artifacts that ultimately it has not been included in this study except to mention it. In general, however, a resin with a higher density is usually void of inclusions or gas bubbles, and therefore is considered of higher quality.

Qualitative Analysis

· Color: The color of all the resins present ranged from a milky, pale yellow (Fig. 9) to a deep, almost blackish red (Fig. 10). Many different color variations between light yellow and dark red were present; instead of assigning each artifact to one of these many colors, a numerical scale was used instead. The scale ranged from 1 to 10, 1 being the lightest color, and ten being the darkest.

Figure 9: Bead with a color value of "3" 51-6-363

Figure 10: Bead with a color value of "9" 61-5-82

· Craftsmanship: Craftsmanship in this instance was also considered on a numerical scale of 1 to 10, 1 being of the lowest quality, and 10 being of the highest. The quality was determined on the basis of the smoothness of the surface, the artistic execution of any details on the piece, and the uniformity of the shape of the entire artifact. These qualities for each artifact are undoubtedly altered from the original in varying degrees, as the overall quality of each item most likely decreased due to being buried and unearthed in excavations. Despite this, there were obvious differences in craftsmanship between sites. In order to make the process of assigning a value as scientifically sound as possible, the artifacts were examined and compared once again at the end of the study in order to ensure that the values were consistent.

· Clarity: This quality, like color and craftsmanship, was considered on a 1 to 10 scale: opaque items were recorded as a 1, while glass-clear items were 10. The clarity of a resin was commonly an indicator of quality, and the clearest resins were considered of a higher value than opaque pieces. Some types of resins are also clearer than others, and this quality of a piece, compared to the local trees and plants of the area, can give a range of possibilities for what resin type was used and/or how this resin was obtained.

Figure 11: Bead from Tell as Sai'diyyah with an opacity value of 8 (86-18-611)

· Inclusions or Bubbles: The presence of any inclusions, bubbles, or internal cracks were recorded for each item. The number of these inclusions was not recorded, but simply marked with a yes or no, for present or not present, respectively. The observation of inclusions, bubbles, and internal cracks was largely dependent on the clarity of the artifact, and it was expected that objects with a higher clarity would also have a more common presence of these inclusions. The presence of inclusions and bubbles usually is indicative of a lower-quality resin.

· Style or Type: The style of the artifact was used to indicate what the resin object had been primarily used for. Common examples are beads, incense (most likely in the form of crumbled resin), and small figurines (none in this study).

· Shape: The shape of the artifact was largely dependent on its form and function. Often, the shape of resin objects was reliant upon the shape of the original resin obtained. As Harding and Hughes-Brock write,

> Often they have a flat side (perhaps where the resin lay against the bark of the tree) and a domed top, i.e. a rather plano-convex shape. Other pieces are more or less triangular in

> section, but often irregular; hence the lopsided shapes so typical of, and generally peculiar to, beads of amber, and the rather less common polygonal or prismatic shapes. Such pebbles need not be much worked to make satisfactory beads. A hole must be bored, corners smoothed off to produce a more or less circular outline, and the surface ground away as far as weathering necessitates. The working is not difficult in such a soft material (only 2-24 Mohs scale) and can be done with sand or emery (1974: 154).

The shapes of the artifacts observed were: semi-circular (Fig. 12), oblong (Fig. 13), spherical (Fig. 14), rectangular (Fig. 15), square (Fig. 16), circular (Fig. 17), geometric (Fig. 18), and crumbled (mostly broken, or intentionally without shape, Fig. 19). A "geometric"-shaped artifact was one which was not rectangular nor square, but still was predominantly shaped with straight lines and flat planes, as seen in the examples.

Figure 12: Example of "semi-circular" shape (33-47-72)

Figure 13: Example of "oblong" shape (65-31-728)

Figure 14: Example of "spherical" shape (86-18-596)

Figure 15: Example of "rectangular" shape (65-31-728)

Figure 16: Examples of "square" shape (CG841912)

Figure 17: Example of "circular" shape (63-5-275)

Figure 18: Examples of "geometric" shape (29-65-438)

Figure 19: Example of "crumbled" artifact (61-14-753)

Once the data were collected (and all objects were photographed), the exploratory analysis began. Since the primary focus of this investigation was to compare resin artifacts between sites, all displayed data were produced with an emphasis on the differences between sites. Additional images were created to display specific attributes in comparison with each other. Due to two large items in the sample, the top outlying values in the boxplots displaying size variance included in the next section had to be compressed for readability. Results remained unaffected.

Section 4: Results and Discussion

Through detailed statistical analysis it was ascertained that there are indeed qualities of resin artifacts that are distinct between sites. In order to better categorize the results, the observations made in this study will first be listed by the separate categories of size and estimated volume, weight, craftsmanship, clarity, inclusions and cracks, color, function, and shape.

Quantitative Values

Estimated Volume:

The size of the artifact in relation to its site of origin is arguably one of the most important aspects of this study; the average size of resin pieces provides information about where sites possibly acquired these pieces (some varieties of resin-producing plants only produce small amounts at a time, for example, resulting in smaller pieces), what family of tree or plant it could have originated from, or even the tendency to reuse valuable materials at these sites. Below, in Fig. 20, is a boxplot displaying a comparison of estimated volume sizes of the artifacts compared between sites. As noted earlier, resins from Estakhr, as Sai'diyyah, Beth Shean, Rayy, Hissar, and Ur are few in number and, while they have been included for the sake of comparison, no definite conclusions should be drawn about resin qualities and use from those sites until more samples are acquired. However, we can see from the sites with significant amounts of artifacts (five or more) that there are trends in estimated volume of these artifacts which can be taken into

account. The volume total here is displayed as the ln(EstimatedVolume) in order to give a better representation of the numerical averages between sites. This is due to the presence of several large outliers in the sample, which would skew the plot. At Hasanlu a large range of volumes is recorded for the resin pieces with outliers both above and below the interquartile range. The majority of the resin artifacts have a ln(EstimatedVolume) between 7.75 and 9.25, a much larger average than any of the other sample sites. Possibly, this larger size is the reason that there were so many resin pieces found in excavations at Hasanlu. For this display it benefits the study to point out the average estimated volume of Hissar. Hissar's sample is comprised of only two beads, therefore giving the large (but misleading) range.

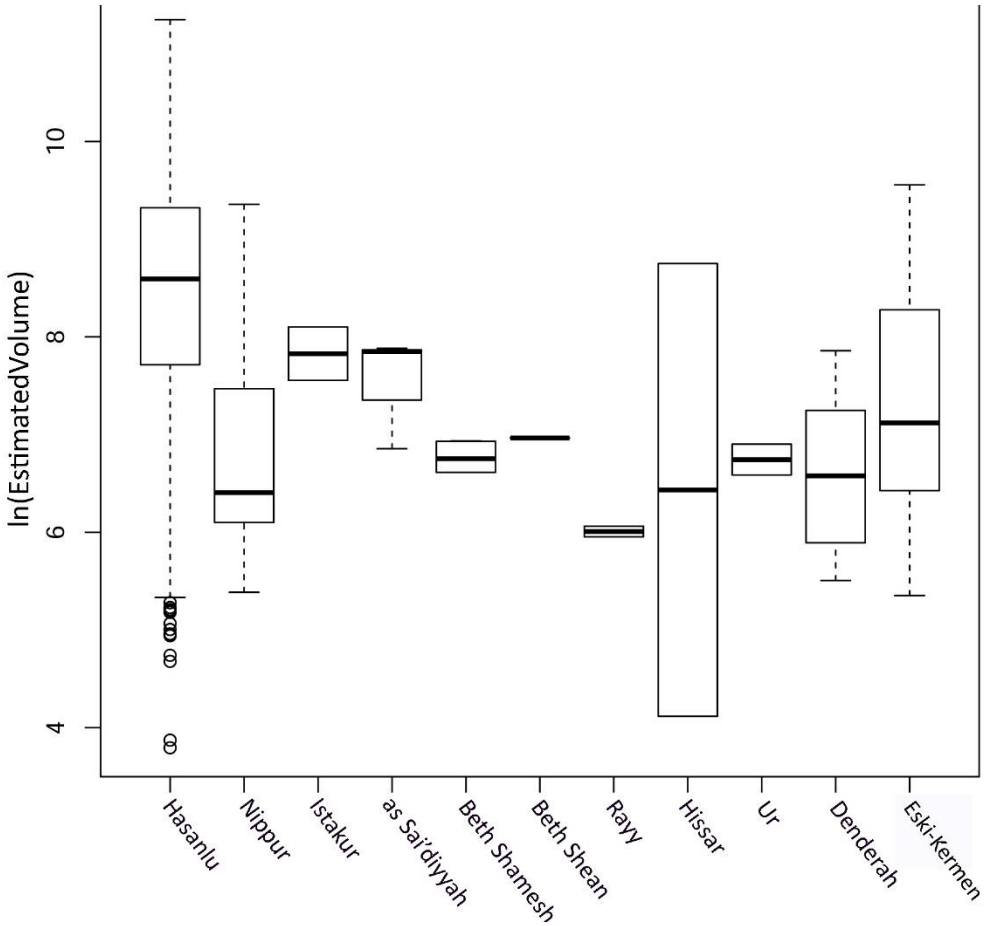


Figure 20: Box and whisker plot displaying the ln(EstimatedVolume) distribution of the eleven sites in mm^3

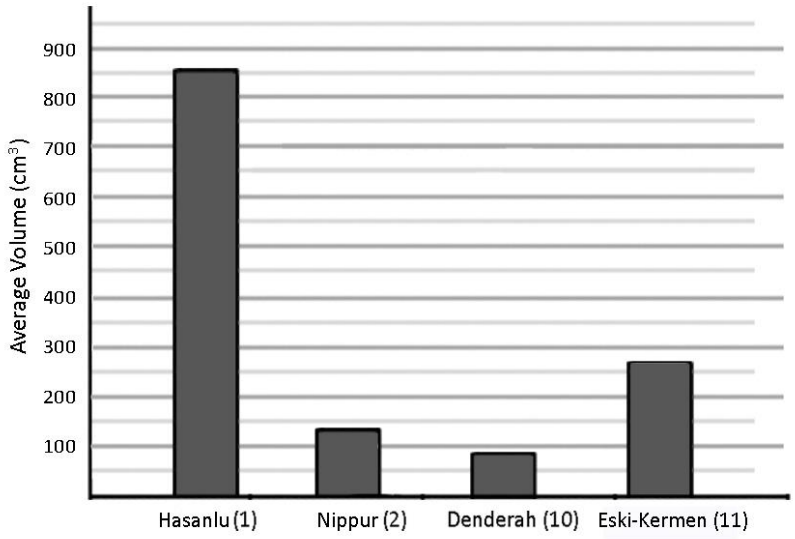


Figure 21: Bar graph comparing the average estimated volumes for the four main sites

Weight:

Below in Fig. 22, the log(Weight) of these artifacts is displayed according to site. Ln(weight) is used for the same reasons as in Fig. 20 (explained above). Here it is clear to see that weight is less variable between sites than overall size, represented as estimated volume. Hissar, Ur, Denderah, and Eski-Kermen all have a median of just below 0, while sites Estakhr, as Sai'diyyah, and Beth Shean share a median of around .5. It is unsurprising to note that Hasanlu has the largest range in addition to the heaviest average weight of its resin objects. Eski-Kermen's weight displayed here is identical to the representation of volume visually displayed in Fig. 20. Altogether, comparing this plot to the plot of ln(EstimatedVolume) results in an ultimately similar depiction. This shows that in the samples of resin, the estimated density of these objects (of assumedly variable resin types) is roughly similar for all of them. Eski-Kermen is the only site with slightly denser samples on average. Based on Eski-Kermen's proximity to

Romania and southern Russia, one can predict from its location and denser resins that its artifacts are most likely some form of amber.

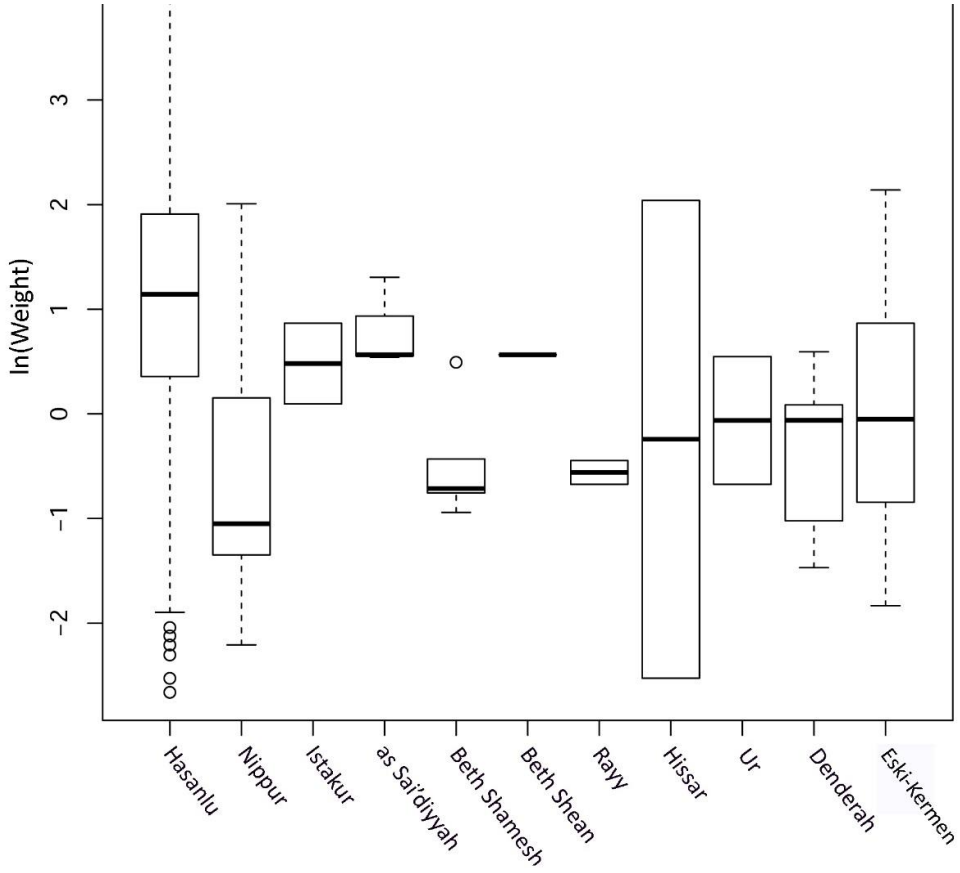


Figure 22: Box and whisker plot displaying the log(Weight) distribution of the eleven sites

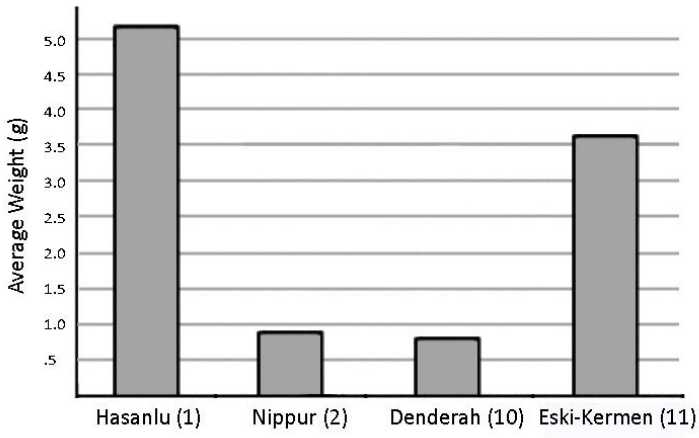


Figure 23: Bar graph comparing the average weight of the four main sites

Qualitative Values

Craftsmanship:

Craftsmanship of the resinous artifacts, while a subjective measure, was still an important factor to include in a study comparing artifacts. In the entire sample, a skill range between 2 and 5 were the most commonly observed. This prevalence of a low-to-middle range level of craftsmanship perhaps indicates that resin was not as hard to work with (or as highly-priced) as other materials used for the same decorative purposes, and were therefore given to less-experienced carvers to work with. However, there is a marked variance in craftsmanship level between the sites. Hasanlu, for example, has resin artifacts that exhibited in general a higher quality than at the other sites – 79% valued between skill levels 4 and 6.

Figure 24: Examples of high craftsmanship levels (71-23-361) (65-31-389)

On average, Nippur shows a slightly lower craftsmanship level, with the majority spread between levels 2 and 4. While it is not statistically significant, it is noteworthy that both objects from Estakhr, possessed very high levels of craftsmanship. This could possibly indicate that there were more highly-skilled workers/ jewelers at Estakhr, or that these artifacts were obtained in trade from the same seller, or even that these two beads were simply carved at a later period with more techniques and tools available. Tell as Sai'diyyah, Beth Shean, Hissar, and Ur contain

too few artifacts and are too spread out to analyze critically besides to make the information available. Beth Shemesh exhibits a predominantly low craftsmanship level (two artifacts, however, are crumbled, and therefore craftsmanship does not apply as a category to them.) Rayy shares a phenomena similar to Estakhr in having too few artifacts to be statistically relevant, but the artifacts that are present show a high craftsmanship level.

Denderah, unlike the other sites, seems to exhibit a clear division in the craftsmanship of its resin pieces. 35.3% of resin artifacts from Denderah are categorized under a craftsmanship level of 3, while 64.7% of artifacts are classified as levels 6 or 7. Such a gap between sets of similar objects could indicate two or more separate processing centers for these goods. Two or more workshops in the business of making beads, possibly using amber or resin exclusively, could employ artisans of different skill levels. Another possibility is that these artifacts were obtained through trade as completed beads from different areas with consequentially different skill levels. Eski-Kermen's artifacts are all contained within craftsmanship levels between 1 and 4, showing an overall lower level of craftsmanship than all other sites except Beth Shemesh.

Craftsmanship of Resin Samples

Site	*Unknown*	%	**1**	%	**2**	%	**3**	%	**4**	%	**5**	%	**6**	%	**7**	%	**8**	%
Hasanlu (1)	6	2.9	0	0	27	13.2	7	3.4	41	20	78	38	43	21	2	1	1	0.5
Nippur (2)	0	0	0	0	14	27.5	19	37.2	13	25.5	3	5.9	2	3.9	0	0	0	0
Estakhr (3)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	100	0	0
as Sai'diyyah (4)	0	0	0	0	0	0	0	0	1	33.3	0	0	1	33.3	1	33.3	0	0
Beth Shemesh (5)	2	40	1	20	2	40	0	0	0	0	0	0	0	0	0	0	0	0
Beth Shean (6)	0	0	0	0	0	0	0	0	0	0	1	100	0	0	0	0	0	0
Rayy (7)	0	0	0	0	0	0	0	0	0	0	0	0	2	100	0	0	0	0
Hissar (8)	0	0	0	0	1	50	1	50	0	0	0	0	0	0	0	0	0	0
Ur (9)	0	0	0	0	1	50	0	0	0	0	1	50	0	0	0	0	0	0
Denderah (10)	0	0	0	0	0	0	12	35.3	0	0	0	0	19	55.9	3	8.8	0	0
Eski-Kermen (11)	1	3.5	4	13.8	8	27.6	11	37.9	5	17.2	0	0	0	0	0	0	0	0

Table 1: Craftsmanship of Resin Samples

Clarity:

The opacity of this sample of resin artifacts ranges from completely opaque to fairly clear, almost transparent. This wide range of clarity could be explained by the use of different tree resins, different manufacturing techniques of the furnished product (many samples seem to be opaque because of the abundance of cracking and fissures within and on the surface – see Fig. 25), or simply because of chemical changes over thousands of years (Beck 1970).

Figure 25: Example of a resin bead with severe cracking (75-29-232)

At Hasanlu, 89.2% of the artifacts were completely opaque. This is a resounding majority, and could have resulted from any of the possible causes listed above. Nippur's sample, as well, is predominantly made up of opaque pieces. However, four pieces show a medium level of clarity, and the variance in opacities should be noted for Nippur. Estakhr's two pieces are both completely opaque. Sai'diyyah, on the other hand, has the three resin artifacts of the highest transparency out of the entire sample. While overall not statistically significant, it is still valuable to know that the three objects from as Sai'diyyah share this characteristic, which may be important in further analysis and possibly even identification of the resin or amber itself. Beth Shemesh has little variance; 80% of the samples are opaque. Beth Shean, Rayy, Hissar, and Ur have few artifacts, but range from completely opaque to medium-low clarity.

Denderah, however, is interesting; it has the most variety of opacities, ranging from 1 to 7. This wide range seems unusual and unlikely; the same resin buried and (presumably) excavated in the same fashion should not have this much variance in a key characteristic of resin. It is more likely that these are different varieties of resin, perhaps obtained through different trade connections. Eski-Kermen also shows some variance, but not to the extent of Denderah. Possibly, however, Eski-Kermen also obtained its amber and resin from several sources, as Denderah most likely did.

Opacity of Resin Samples

Site	1	%	2	%	3	%	4	%	5	%	6	%	7	%	8	%
Hasanlu (1)	183	89.2	11	5.4	6	2.9	2	0.9	0	0	3	1.6	0	0	0	0
Nippur (2)	40	78.5	7	13.7	0	0	2	3.9	2	3.9	0	0	0	0	0	0
Estakhr (3)	2	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
as Sai'diyyah (4)	0	0	0	0	0	0	0	0	0	0	0	0	2	66.7	1	33.3
Beth Shemesh (5)	4	80	0	0	0	0	1	20	0	0	0	0	0	0	0	0
Beth Shean (6)	0	0	0	0	0	0	0	0	0	0	1	100	0	0	0	0
Rayy (7)	0	0	0	0	2	100	0	0	0	0	0	0	0	0	0	0
Hissar (8)	1	50	1	50	0	0	0	0	0	0	0	0	0	0	0	0
Ur (9)	0	0	0	0	1	50	1	50	0	0	0	0	0	0	0	0
Denderah (10)	2	5.9	4	11.7	11	32.4	5	14.7	7	20.5	3	8.9	2	5.9	0	0
Eski-Kermen (11)	14	48.3	10	34.4	4	13.8	1	3.5	0	0	0	0	0	0	0	0

Table 2: Opacity of Resin Samples

Inclusions/ Cracks:

The results obtained from examining the inclusions found in the pieces were relatively straightforward; most objects (93.4%) did not contain any inclusions. While this result may seem normal, the amount of debris and organic material caught in resins was expected to be much higher. As Edward Berry states, "[o]ne might expect that the chances of many different kinds of things being caught in such small amounts of gum to be exceedingly slender, and yet more than two thousand different kinds of insects, spiders and plants have been described from the Baltic amber alone," (1927: 271). However, this examination was also hindered by the opacity of the objects. In the opaque artifacts, inclusions might be present but could not be visually detected. This category, however, was aimed to work with the idea that some inclusions

in resins and amber could be considered of more value, rather than less (Causey 2012). Inclusions would only change the value of a piece if they could be seen, therefore it is a moot point in this case to study the inclusions in opaque resins. The only conclusion reached from this category is that inclusions in resins clear enough to observe were rare, and no inclusions in the sample were like the insects and even lizards that Causey suggests could increase the value. Instead, all inclusions were limited to what looked like dirt, pollen, tiny bark chips, or other organic debris. It is interesting to note, however, that 38.2% of Denderah's artifacts contained inclusions compared to the usually <1% rate of the other sites. If considered with the fact that often copals, such as those found in East Africa and Madagascar, are very rich in inclusions, then this could lead one to think that the high amount of inclusions found in Denderah's resin pieces indicate that their place of origin is eastern Africa (Meyer et al. 1991: 295). This is a valid possibility, but one must also consider that Denderah's resins showed a higher tendency towards clarity as well, and the resulting effect could be the identification of the inclusions otherwise hidden in resin from other sites.

Inclusions in Resin Samples

Site	Present	%	Absent	%
Hasanlu (1)	2	1	203	99
Nippur (2)	4	7.8	47	92.2
Estakhr (3)	0	0	2	100
as Sai'diyyah (4)	1	33.3	2	66.7
Beth Shemesh (5)	0	0	5	100
Beth Shean (6)	0	0	1	100
Rayy (7)	0	0	2	100
Hissar (8)	0	0	2	100
Ur (9)	1	50	1	50
Denderah (10)	13	38.2	21	61.8
Eski-Kermen (11)	1	3.4	28	96.6

Table 3: Inclusions in Resin Samples

The presence of cracking and fissures in the resin artifacts was another aspect noted in addition to the inclusions. This quality of the sample does not necessarily reflect any state of the

objects at the time of their use; it is likely that the cracks in many of these resin objects occured after they were buried. "The breakdown of the cortex causes cracking, fissuring, flaking, chipping, and, eventually, fractures. Only a very few ancient pieces retain something of their original appearance, in each case because of the oxygen-free environments in which they were buried," (Causey 2012). The presence of cracks seems fairly evenly-divided in samples from each site except for at Hasanlu, where only 6.8% were found to have cracks. Besides obstructing the clarity of an object, as mentioned before, no conclusions have been reached in this study by the presence of cracks alone. However, the prevalence of cracking in samples from some sites in comparison to others could potentially be the basis for the future study of resins and the reaction of different families of resins to pressure and time.

Cracks in Resin

Site	Present	%	Absent	%
Hasanlu (1)	14	6.8	191	93.2
Nippur (2)	16	31.4	35	68.6
Estakhr (3)	1	50	1	50
as Sai'diyyah (4)	1	33.3	2	66.4
Beth Shemesh (5)	1	20	4	80
Beth Shean (6)	0	0	1	100
Rayy (7)	0	0	2	100
Hissar (8)	1	50	1	50
Ur (9)	0	0	2	100
Denderah (10)	11	32.3	23	67.7
Eski-Kermen (11)	14	48.3	15	51.7

Table 4: Cracks in Resin

Color:

By glancing at Table 5 below, it is easy to see a trend in the color of the sample towards a medium level of darkness, leaning towards the darker end of the spectrum. It is only at as Sai'diyyah that any tendency towards lighter colors is seen: the possibility that this distinction is an indicator of different types of resin from other sites is likely, although the colors of resin are not necessarily an indicator of origin. Looking at this quality of the resin pieces, the two most

interesting sites are Hasanlu and Denderah, both of which have resin color values across the scale. This wide variance in color could denote many things, but most likely indicates multiple types of resin coming from multiple sources, obtained through different trade routes at both sites. Whether or not certain colors of resin were preferred is hard to say, but it is difficult to attribute the prevalence of medium-to-dark colored resins to personal preference alone and, more likely, this color was the most common color available to these sites. Eski-Kermen is well spread also, but with a heavier tendency towards the darker color. Even in Hasanlu and Eski-Kermen, the most common color value was between 5 and 7 (77% were between these values at Hasanlu, and 82.6% at Eski-Kermen). Denderah is peculiar due to the high variance it displays, (like Hasanlu), but is unique in that its two color tendencies are situated at value 3 (17.6%) and between values 9 and 10 (41.2%). This contrast at Denderah was noted before when discussing the craftsmanship category, and is interesting to note again in relation to color.

Color of Resin Samples																		
Site	2	%	3	%	4	%	5	%	6	%	7	%	8	%	9	%	10	%
Hasanlu (1)	1	0.5	4	1.9	18	8.8	77	37.5	57	27.8	24	11.7	16	7.8	5	2.4	3	1.6
Nippur (2)	0	0	1	1.9	5	9.8	12	23.6	19	37.2	9	17.7	4	7.9	1	1.9	0	0
Estakhr (3)	0	0	0	0	0	0	2	100	0	0	0	0	0	0	0	0	0	0
as Sai'diyyah (4)	0	0	1	33.3	2	66.7	0	0	0	0	0	0	0	0	0	0	0	0
Beth Shemesh (5)	0	0	0	0	2	40	2	40	0	0	1	20	0	0	0	0	0	0
Beth Shean (6)	0	0	0	0	0	0	1	100	0	0	0	0	0	0	0	0	0	0
Rayy (7)	0	0	0	0	0	0	0	0	2	100	0	0	0	0	0	0	0	0
Hissar (8)	0	0	1	50	0	0	0	0	1	50	0	0	0	0	0	0	0	0
Ur (9)	0	0	0	0	0	0	0	0	0	0	1	50	1	50	0	0	0	0
Denderah (10)	1	2.9	6	17.6	2	5.9	2	5.9	3	8.8	2	5.9	4	11.8	5	14.7	9	26.5
Eski-Kermen (11)	0	0	0	0	1	3.5	3	10.4	10	34.4	10	34.4	4	13.8	1	3.5	0	0

Table 5: Color of Resin Samples

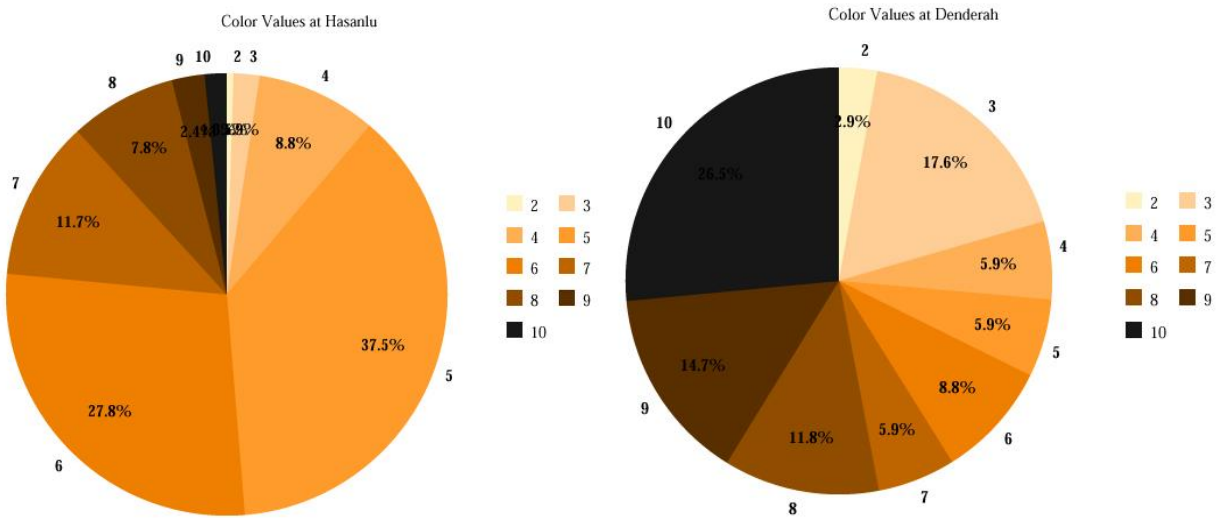


Figure 26: Pie charts of color values at both Hasanlu and Denderah

In the identification of resin sources one has a tendency to want to group artifacts based on color – perhaps the most obvious aspect of each piece. However, as exemplified by the multiple shades and hues of Baltic amber alone, all of which originate from roughly the same geographical point, color alone is an unreliable indicator of original location (see Fig. 27 below).

Figure 27: The many different colors of Baltic amber (Amber Workshop 2006)

Color does not necessarily indicate a significant change in chemical composition, and the color of these resins in particular could have been altered due to aging or burial, or even the exposure to air after excavation. As Navarro states in his study of the amber trade, "[t]he colour of a specimen is no criterion, for a great diversity of hues is found both in succinite (northern amber) and simetite (the Sicilian variety); furthermore, the action of certain soils tends to alter the original colour" (1925: 481). A possible preference for color in amber and resin, however, can give insight into what ancient Near Eastern peoples valued in amber and resins, and even could extend into their preferences towards other stones and jewelry. Color is best utilized as an indicator of a resin's value, not necessarily its place of origin or biological type. Below, we see craftsmanship as compared with color, Fig. 28. Overall, a larger sample size is needed to make statements about craftsmanship values in relation to darker or lighter resin colors, but judging from this sample, it seems that a lower skill level was often seen with resins of darker colors. Judging from the fact that darker colors were much more numerous in this sample than lighter colors, darker-colored resins could have been seen as less-valuable in the ancient Near East, and therefore more were given to less-skilled artisans to carve. It is possible that the darker-colored resins were even carved by people without any particular training or expertise, like wood is whittled to pass time.

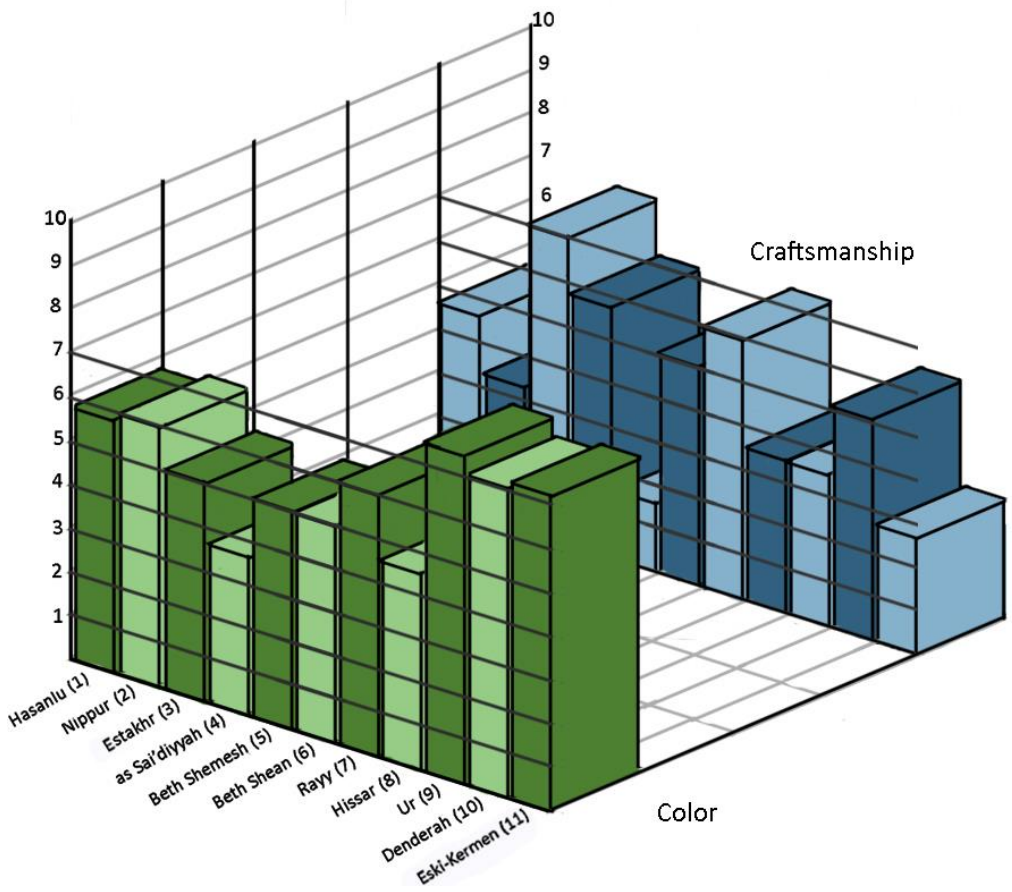


Figure 28: A comparison of average color values to average craftsmanship values

Function/ Type:

While predominantly comprised of beads, this study also took note of the particular varieties of beads which cropped up often in the sample. There was not enough variation among bead types in order to classify them with detail, but rather these categories attest to the fact that there *are* different types of resin. The presence of other types of resin artifacts besides beads, however, primarily provide insight into other uses for resin.[12] In this sample, tokens (pieces of resin without a hole through it) and resin bits (or crumbled resin) were the two other types

[12] While this study does not address in detail the uses/ forms of resins over time, it is important to note that the increasing complexity and changing developments of the Early Bronze Age in the Near East have been linked to "contemporary sociopolitical developments" in Egypt (Baxevani 1992: 93). It therefore should be considered that resin uses and forms from this period onward could have indeed been affected by this pharaonic culture to the south.

present apart from beads. Beads were divided into normal beads, spacer beads (large, with two or more holes, see Fig. 29), and "seed beads", or, very tiny beads.

Figure 29: Example of a large spacer bead (65-31-389)

As seen in Table 6, beads are the most numerous. However, this exponential presence of beads over other types and uses of resin implies that it was most commonly used in jewelry. While this conclusion is possible, it is also important to note other potential factors in this pronounced bias towards beads. Beads as an archaeological artifact are much easier to see and recover in an excavation than crumbled resin (often incense) and hardened resin that once was liquid (varnishes and adhesives, as mentioned in Section 2). Current knowledge of resin as an ingredient and incense come from the chemical testing of pottery and stores present in unbroken containers – not excavated separately as its own entity, like the beads and tokens. It should be noted that in an article discussing the rare find of an amber knife handle, the author discusses the fragility of amber and resins: "relatively few utility objects such as knife-handles have survived, and these generally in circumstances of burial where the apotropaic qualities of the material would outweigh practical considerations," (McCarthy et al. 1983: 268). Therefore, it is an obvious conclusion that most of the resin found is in the form of jewelry; this does not necessarily mean that resin was most commonly used as jewelry. This study focuses primarily

on resin artifacts in the form of beads and tokens. As can be expected from its largest sample size, Hasanlu has the most variety of resin types.

Type/ Function of Resin Samples

Site	Bead	%	Spacer Bead	%	Seed Bead	%	Token	%	Resin Bits	%
Hasanlu (1)	192	93.7	5	2.4	1	0.5	3	1.5	4	1.9
Nippur (2)	51	100	0	0	0	0	0	0	0	0
Estakhr (3)	2	100	0	0	0	0	0	0	0	0
as Sai'diyyah (4)	3	100	0	0	0	0	0	0	0	0
Beth Shemesh (5)	4	80	0	0	0	0	0	0	1	20
Beth Shean (6)	1	100	0	0	0	0	0	0	0	0
Rayy (7)	2	100	0	0	0	0	0	0	0	0
Hissar (8)	1	50	0	0	1	50	0	0	0	0
Ur (9)	2	100	0	0	0	0	0	0	0	0
Denderah (10)	34	100	0	0	0	0	0	0	0	0
Eski-Kermen (11)	28	96.5	0	0	0	0	0	0	1	3.5

Table 6: Type/ Function of Resin Samples

Shape:

Material culture's "style" is considered as "an aspect of material patterning which is thought to respond to primarily social and cultural demands or constraints," (Dietler and Herbich 1998: 237). Different "styles" of amber and resin objects could show ethnic differences between these sites in terms of jewelry use, resin use, etc. There is not enough information in order to compare diachronically the differences between amber and resin artifacts, but it is safe to say that differences in style would be minimally, if at all, observable. Because of the sample's bias towards beads, it is important to note differences in not only the size or hole-number of the bead, but also its shape; in this study alone bead shapes fell into eight separate (and broad) categories, including crumbled (as mentioned earlier, used for incense). While eight categories are presented here, some beads within the same category were so dissimilar that a larger sample size or a more detailed study would likely expand the shape categories. In this study, these eight categories proved sufficient to show relationships and trends between sites. Looking at Table 7, oblong beads stand out as the most numerous. Yet, it is hard to label "oblong" as a definitive

bead shape across the ancient world, and a more precise definition would label beads that are longer rather than thicker. These are the most popular.

Hasanlu has the widest variety of shapes, most likely due to the sheer number of artifacts in the designated sample. Overall, a tendency towards long and thin beads was observed at Hasanlu, even as circular and semi-circular shapes were also fairly common. At Nippur, an overwhelming majority of shapes were oblong. Like Hasanlu, there was a greater tendency towards long and thin beads (80.3%) than other shapes, with a smaller amount of circular and semi-circular beads in comparison (4%). Estakhr is exceptional, because the two beads found there were the only two square-shaped pieces in the entire sample. As noted above when discussing craftsmanship, both beads were given a skill value of 7. It is clear that these two beads were part of a carefully-crafted set, but beyond the presence of these two square beads nothing can be statistically deduced from them. Rayy is similar to Estakhr in that both beads found there are one shape – in this case, spherical. The craftsmanship of these two pieces was also quite high (at a level of 6), definitely a comparable situation to that of Estakhr. Beth Shemesh is mostly comprised of oblong-shaped beads.

As Sai'diyyah, Beth Shean, Hissar, and Ur all have varied shapes of beads. As before, the small number of pieces from each site render any data statistically insignificant and offer no deep insights into amber and resin shapes except to show a presence of certain shapes at each site. For example, from this data it is possible to correctly state that since Beth Shean yielded a spherical bead, spherical beads were used and possibly produced at Beth Shean.

Denderah is highlighted by the large number of circular-shaped beads, which make up 91.2% of the site's sample. As Fig. 30 demonstrates, the circular beads are not of similar size,

color, or even opacity. No site numbers or loci are attached to these beads, but it is unlikely, due to their mixed nature, that they came from the same necklace, or even the same provenience.

Figure 30: Circular beads from Denderah (29-65-438)

Denderah, like Nippur, shows a strong tendency towards oblong shapes (72.5%), with a significant amount of semi-circular beads as well (24.1%).

Shape of Resin Samples

Site	Semi-circular	%	Oblong	%	Spherical	%	Rectangular	%	Square	%	Crumbled	%	Circular	%	Geometric	%
Hasanlu (1)	18	8.8	100	48.8	4	1.9	50	24.4	0	0	6	2.9	27	13.2	0	0
Nippur (2)	1	2	41	80.3	5	9.8	3	5.9	0	0	0	0	1	2	0	0
Estakhr (3)	0	0	0	0	0	0	0	0	2	100	0	0	0	0	0	0
as Sai'diyyah (4)	1	33.3	0	0	1	33.3	1	33.3	0	0	0	0	0	0	0	0
Beth Shemesh (5)	0	0	4	80	0	0	0	0	0	0	1	20	0	0	0	0
Beth Shean (6)	0	0	0	0	1	100	0	0	0	0	0	0	0	0	0	0
Rayy (7)	0	0	0	0	2	100	0	0	0	0	0	0	0	0	0	0
Hissar (8)	1	50	1	50	0	0	0	0	0	0	0	0	0	0	0	0
Ur (9)	1	50	0	0	0	0	0	0	0	0	0	0	1	50	0	0
Denderah (10)	0	0	1	2.9	0	0	0	0	0	0	0	0	31	91.2	2	5.9
Eski-Kermen (11)	7	24.1	21	72.5	0	0	0	0	0	0	1	3.4	0	0	0	0

Table 7: Shape of Resin Samples

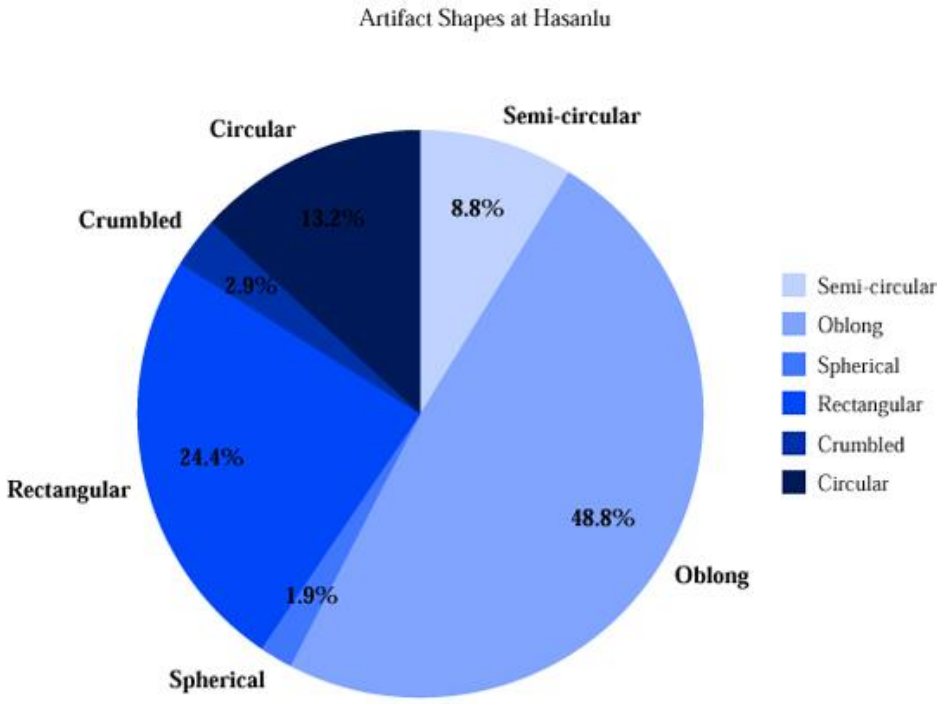


Figure 31: Pie chart showing the varieties of the shapes of resinous artifacts from Hasanlu

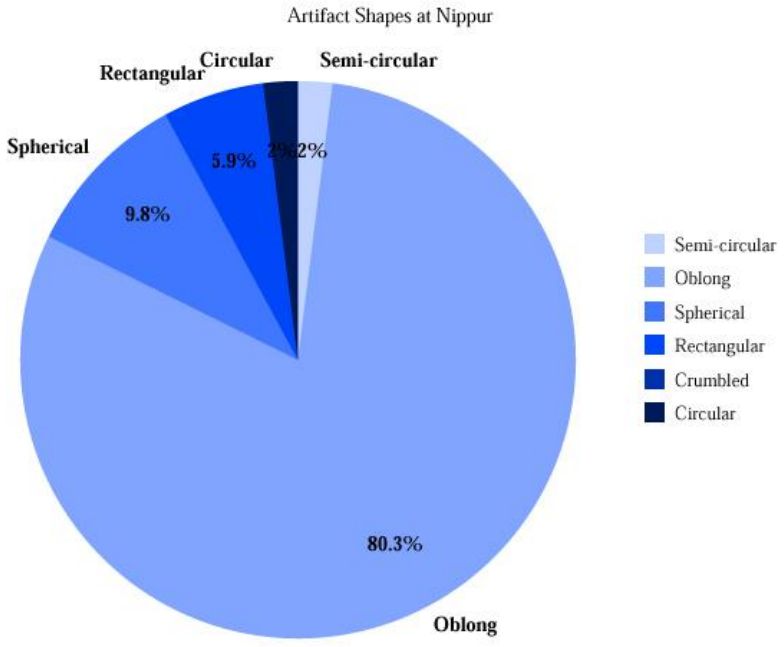


Figure 32: Pie chart showing the varieties of the shapes of resinous artifacts from Nippur

Summary

All aspects of the amber and resin pieces investigated in this study have yielded information about the qualities one can expect to find in resin artifacts at any of the eleven sites. Through the help of Liubo Li and the Ohio State Statistics Consulting Service, it was possible to reverse this prediction by utilizing Fig. 33 on the next page, created from the information gathered in this study, one can take an unknown resin piece from any of these sites and predict which site it came from based on its qualities. Further information gathered in the future from resin pieces at these sites will increase the accuracy and therefore the usefulness of this "reverse identification" procedure. A tool like this would, for example, prove useful in connecting a resin from one of these sites with the correct site of origin, or even possibly an unknown resin *not* from one of these sites with the area surrounding the site which it most closely matches. To utilize a tool like this most effectively, more research into resins is required.

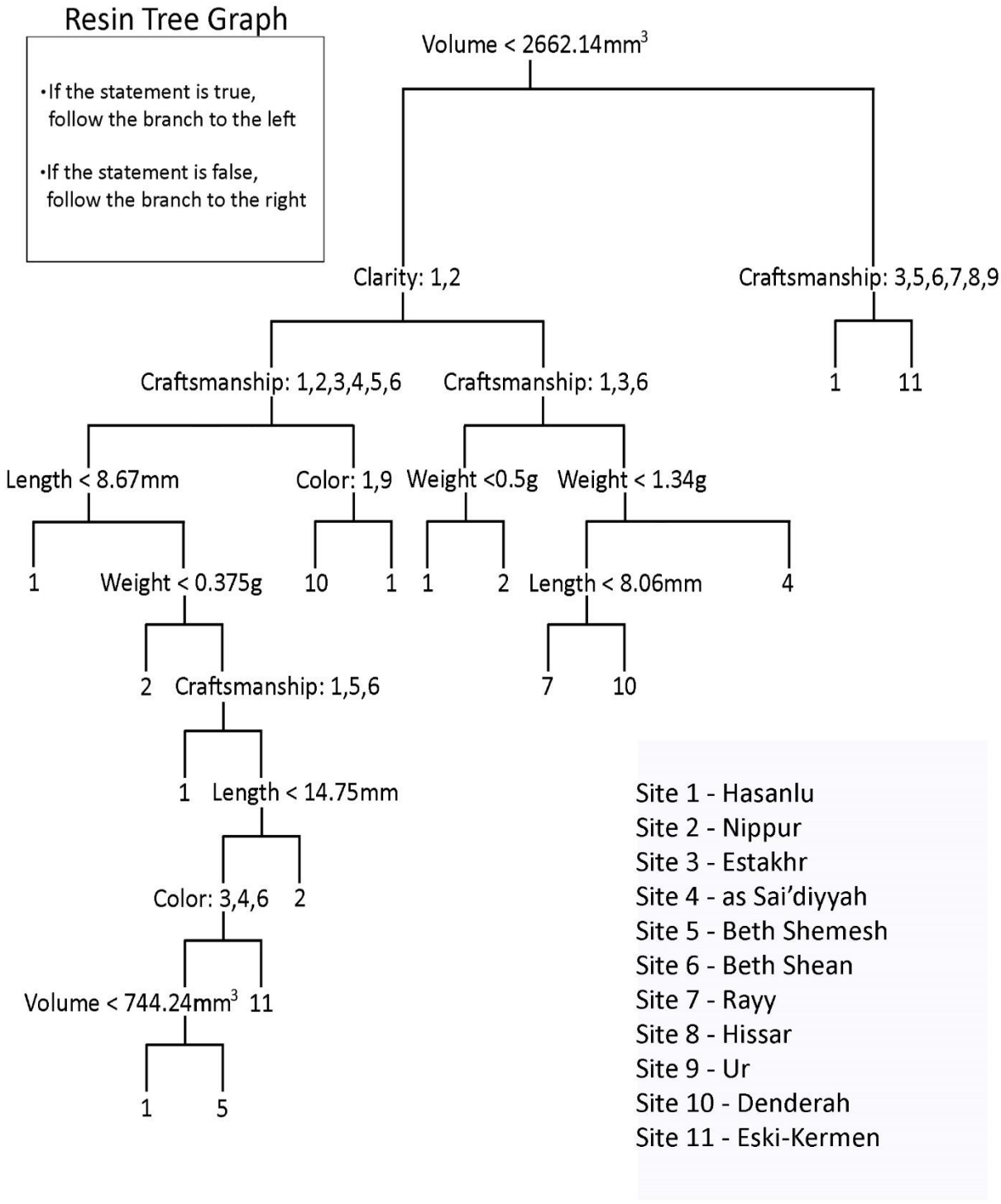


Figure 33: Tree graph allowing for the retracing of the resin samples to the eleven sites in this study (courtesy of Liubo Li)

Section 5: Concluding Statements

Through analyzing the quantitative and qualitative attributes of the resin artifacts included in this study from eleven different sites, definite trends and differences were observable site-to-site. This inter-site comparison is important in not only making statements about a site's tendencies involving material culture, but also forms the base for an investigation into the biological origins of these resins and the further study of amber and resin trade routes in the ancient Near East. For the sites with a large enough sample size, differences between the characteristics and treatment of resin and amber were clearly demonstratable, which can lead to a discussion of cultural exchange and the differences in materials-processing at these sites. For example, as mentioned earlier in Section 2, it has been theorized that ivory-carvers doubled as amber-carvers. In this study it became clear that sites possessing similar cultures or that were geographically close to each other yielded similar resin artifacts, showing evidence of cultural exchange and the use of resins from the same biological origin or area which can be further explored in future studies of this subject.

The subject of revealing and predicting trade routes in the ancient Near East, however, is vastly complicated. Beck warns against equating the discovery of one or two artifacts with trade. He suggests instead three requirements for judging the presence of amber trade:

> 1. Authenticity. Any find that is to be used in evidence of trade must be shown to be of amber in the strict sense of that word: the fossil resin specifically called Baltic amber, or, more precisely, succinite, occurring naturally only in northern and eastern Europe.
> 2. Natural Unavailability. An artifact of authentic Baltic amber in a Danish bog burial does not demonstrate trade since Baltic amber is indigenous to Denmark. The second criterion to be met is thus the absence of naturally occurring Baltic amber in the area where an archaeological find has been excavated.
> 3. Quantity. The notion of trade implies the repeated movement of a significant volume of goods to the effect that a quantity of goods has been transferred; specifying a quantity that would be an acceptable criterion for inferring trade is extremely difficult (1985: 200-202).

While the above requirements are restricted to the trade of amber, it can be applied to all resins upon changing the definition of authenticity to fit this broader spectrum. With this in mind, and with only this preliminary investigation of Near Eastern resins, it is not possible to reach any larger conclusions on the subject of resin trade other than that it was present and thriving. Local resins in the ancient Near East were being traded even before the onset of the Bronze Age created a funnel for European amber to come into the Near East.

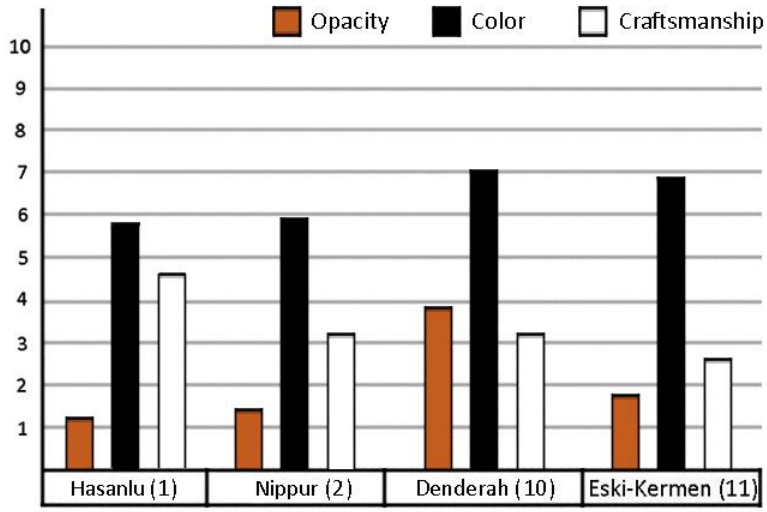


Figure 34: Bar graph comparing the average values of opacity, color, and craftsmanship for the four main sites

Of further interest in future studies of this nature is the methodology used in this investigation. The use of numerical scales from 1 through 10 in assigning values to qualitative characteristics like color, opacity, and craftsmanship allowed for easy comparison between the artifacts and between the sites. Fig. 34 displays the averages of these characteristics for the four sites with the largest samples. Clear differences can be seen between the characteristics of these sites, and this study consistently maintained the use of a numerical value scale throughout. These same attributes and scale system can be employed in not only further analyses of resins

and amber, but also in future studies of other precious stones and materials such as lapis lazuli, gold, or gemstones. All of the same categories analyzed in this study would apply to future studies of the same nature (except, perhaps, for opacity, which would be limited to gemstones). For a largely investigative study such as this, these categories and the scale used were useful in determining similarities and differences between artifacts and sites.

Future Directions of this Study

The most prominent requirement in continuing this study is that more amber and resin collections should be analyzed to increase the sample size and to expand the number of sites in focus. Ideally, a sample size of 30 or more pieces of resin at each site would be analyzed in order to provide statistically relevant data. As much information as possible about the provenience and related data of these artifacts should be obtained in order to differentiate between pieces from different time periods and different contexts (resins found in graves, for example, hold different connotations than resins found in temples, houses, or other areas.) An expansion of the number of sites in the ancient Near East is crucial to continuing this study as well; more information about resins in sites of all areas and time periods of the ancient Near East is important for being able to reconstruct possible trade routes and other aspects of culture that one at present cannot predict. Chemical testing is a further desideratum.

Tests to differentiate between resins through the chemical analysis of modern resins and amber are necessary to expand the scope of this study. Chemical testing of both modern resins and ancient resins using methods such as Raman Spectroscopy or FTIR to trace resin origin should be utilized. This could reveal ancient trade routes focusing primarily on luxury goods. However, chemical testing is important for many reasons – not only to find a resin's indigenous

area, but also to see if the object is amber or another resin. For example, there were many references to amber's presence in Egypt as early as 3500 BC and the Vth Dynasty; these were proven to be pieces of other, local resin rather than amber. Amber's presence instead of these local resins would have meant a much more extensive trade route was in place than really was present at that time (Harding and Hughes-Brock 1978: 146). For this reason, chemical testing is extremely important to verify theories of trade and the influx of foreign resins, especially before the Bronze Age.

There are many possible methods that can be employed to analyze the resins in this study: Raman Spectroscopy, FTIR, GC-MS, and NMR are just a few that have been already used to test ambers. The most commonly-used method thus far in the study of amber is Fourier Transform Infrared Spectroscopy (FTIR), a popular form of IR testing due to its high spectral resolution and short processing times (Angilini & Bellantini 2005: 443). FTIR characterizes the amber based on its chemical makeup and the resulting wavelength patterns can be compared to other reference patterns produced from known materials. NMR and GC-MS are similar, and all three of these methods have the downside of requiring the destruction of a small piece of the sample in the process.[13] Usually 1 – 3g of amber are used for the extraction in GC-MS, and 30 – 100mg are used for NMR (Angilini & Bellantini 2005: 442). These two methods, because they both take a long period of time and a large amount of material, are not usually employed. FTIR is also destructive (1g or more of material is required) and results can vary depending on the object's exposure to air and the purity of it (Beck 1985: 8-9). Margaret Serpico also warns that FTIR testing between families of resins can often be unreliable (2000: 464). Raman Spectroscopy is similar to FTIR, but is non-destructive, provided that the laser used is kept at a

[13] See Beck 1991 for more information about IR and differentiating between Baltic amber and other resins. Also, see Lambert et al. 1996 for the differences between resin analysis using MS, IR, and NMR.

low power (Vandenabeele et al. 2006: 676). It also will produce a wavelength which can then be matched to wavelengths of control samples. It is unknown yet whether or not there are enough significant differences in the material makeup of different resins to produce a varied wavelength pattern. Modern resins from a known location and biological plant family should be analyzed with Raman Spectroscopy before testing ancient pieces of resin or amber.

Final Remarks

The broad implications of cultural exchange and influence were the questions which prompted this study and as an investigation into the types and characteristics of resin artifacts in the ancient Near East, this information has the potential, when combined with future analysis, to reveal new trade routes through which communities interacted. The connection of the ancient world is incredibly detailed and difficult to uncover without definitive proof, which resins and amber can provide. Through quantitative and qualitative analysis of these artifacts in comparison with artifacts from other sites in the ancient Near East, it is clear that there are differences in characteristics which were most likely caused by differing resin sources and variations in cultural practices. This study has paved the way for future chemical analysis on an increased sample size of resin artifacts, and there is by no means a foreseeable limit on what knowledge can be gained through further study.

Appendix: The Scientific Names and the Common Names of Plants

Scientific Name	Common Name
Pinus halepensis	Aleppo Pine
Pinus pinea	Stone Pine
Pinus brutia	Turkish Pine
Pinus nigra	Black Pine
Cedrus libani	Lebanon Cedar
Abies cilicica	Cicilian Fir
Juniperus oxycedrus	Prickly Juniper *or* Cade Juniper
Juniperus communis	Common Juniper
Juniperus drupacea	Syrian Juniper
Juniperus phoenicia	Phoenician Juniper
Juniperus foetidissima	Foetid Juniper
Juniperus excels	Greek Juniper
Cupressus sempervirens	Mediterranean Cypress
Pistacia atlantica	Mt. Atlas Mastic
Pistacia terebinthus	Terebinth
Pistacia khiniuk	*no common name*
Pistacia lentiscus	Mastic
Pistacia eurycarpa	Qazwan *or* Daraban
Cistus creticus	Pink Rock-Rose
Cistus laurifolius	Laurel Leaf Cistus
Liquidambar orientalis	Oriental Sweetgum
Opopanax chironium	Sweet myrrh
Opopanax hispidium	*no common name*
Opopanax syriacum	*no common name*

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